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THE AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

EDITED BY

COL. CASEY A. WOOD, M. R. C., U. S. A., M. D., C. M., D. C. L.

Fellow of the American College of Surgeons; Emeritus Professor of Ophthalmology, College of Medicine, University of Illinois; Late Professor of Ophthalmology and Head of the Department, Northwestern University Medical School; Ex-President of the American Academy of Medicine, of the American Academy of Ophthalmology, and of the Chicago Ophthalmological Society; Ex-Chairman of the Ophthalmic Section of the American Medical Association; Editor of a "System of Ophthalmic Therapeutics" and a "System of Ophthalmic Operations," etc ; Consulting Ophthalmic Surgeon to St. Luke's Hospital; Consulting Ophthalmologist to Cook County Hospital, Chicago, Ill.

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Volume XV

Retina, Detachment of the to Solution, Carrel-Dakin

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INITIALS USED IN THIS ENCYCLOPEDIA TO IDENTIFY INDIVIDUAL CONTRIBUTORS

A. A.—ADOLF ALT, M. D., M. C. P. AND S. O., ST. LOUIS, MO.
Clinical Professor of Ophthalmology, Washington University, St. Louis, Mo.; Author of *Lectures on The Human Eye; Treatise on Ophthalmology for the General Practitioner; Original Contributions Concerning the Glandular Structures Appertaining to the Human Eye and its Appendages.*

A. C. C.—ALFRED C. CROFTAN, PH. D., M. D., CHICAGO, ILL.
Author of *Clinical Urinology* and of *Clinical Therapeutics.* Member of the General Staff of the Michael Reese Hospital, Chicago. Formerly Physician-in-chief at St. Mary's Hospital; Physician to St. Elizabeth's Hospital; Physician to the Chicago Post-Graduate Hospital; Pathologist to St. Luke's Hospital.

A. E. D.—A. EDWARD DAVIS, A. M., M. D., NEW YORK CITY, N. Y.
Professor of Ophthalmology, New York Post Graduate Medical School and Hospital; Attending Ophthalmic Surgeon Babies' Wards, New York Post Graduate Hospital; Consulting Ophthalmologist Manhattan State Hospital, Central Islip; United Portchester Hospital and Ossining Hospital; Member of the New York Academy of Medicine, New York Ophthalmological, and American Ophthalmological Societies; Author of *The Refraction of the Eye;* Co-author with D. B. St. John Roosa, M. D., *Handbook of the Anatomy and Diseases of the Eye and Ear;* with Beaman Douglass, M. D., *Eye, Ear, Nose, and Throat Nursing.*

A. E. B.—ALBERT EUGENE BULSON, JR., B. S., M. D., FORT WAYNE, IND.
Professor of Ophthalmology, Indiana University School of Medicine; Chairman of the Section on Ophthalmology of the American Medical Association; Ophthalmologist to St. Joseph's Hospital, Allen County Orphans' Home, and the United States Pension Department; Editor of the *Journal of the Indiana State Medical Association,* etc.

A. E. H.—ALBERT E. HALSTEAD, M. D., CHICAGO, ILL.
Professor of Clinical Surgery, Northwestern University Medical School; Attending Surgeon, St. Luke's and Cook County Hospitals, Chicago; Consulting Surgeon, Illinois Charitable Eye and Ear Infirmary; Fellow American Surgical Association.

A. N. M.—ALFRED NICHOLAS MURRAY, M. D., CHICAGO, ILL.
Ophthalmologist, New Lake View Hospital. Formerly Clinical Assistant in Ophthalmology, and Assistant Secretary of the Faculty, Rush Medical College. Once Voluntary Assistant in the Universitaets Augenklinik, Breslau. Author of *Minor Ophthalmic and Aural Technique.* Secretary, Physicians' Club of Chicago. Mitglied der Ophthalmologischen Gesellschaft, Heidelberg.

A. S. R.—ALEXANDER SANDS ROCHESTER, M. D., CHICAGO, ILL.
M. D. Jefferson Medical College; Ex-Chief, San Lazaro Contagious Hospital, Manila, P. I.; Adjunct Ophthalmologist to St. Luke's Hospital, Chicago.

B. C.—BURTON CHANCE, M. D., PHILADELPHIA, PA.
Assistant Surgeon, Wills Hospital, Philadelphia.

C. A. O.—CHARLES A. OLIVER (DECEASED).

C. D. C.—Carl Dudley Camp, M. D., Ann Arbor, Mich.

Clinical Professor of Diseases of the Nervous System in the Medical Department of the University of Michigan. Formerly, Instructor in Neuropathology in the University of Pennsylvania. Member of the American Neurological Association, American Association of Pathologists and Bacteriologists, American Therapeutic Society, American Medical Association, etc. Author of papers on the Anatomy, Physiology and Pathology of the Nervous System.

C. E. W.—Lieut.-Col. Charles E. Woodruff, M. D., U. S. Army, Retired.

C. F. F. C.—Charles F. F. Campbell, Columbus, Ohio.

Superintendent Ohio State School for the Blind; Secretary Ohio State Commission for the Blind; Secretary, American Association of Workers for the Blind; Founder and Editor, "*Outlook for the Blind.*"

C. F. P.—Charles F. Prentice, M. E., New York City, N. Y.

President, New York State Board of Examiners in Optometry; Special Lecturer on Theoretic Optometry, Columbia University, New York. Author of *A Treatise on Ophthalmic Lenses* (1886); *Dioptric Formulæ for Combined Cylindrical Lenses* (1888); *A Metric System of Numbering and Measuring Prisms (the Prism-dioptry)* (1890); *The Iris as Diaphragm and Photostat* (1895), and other optical papers.

C. H. B.—Charles Heady Beard, M. D. (Deceased).

C. P. S.—Charles P. Small, A. M., M. D., Chicago, Ill.

Late Clinical Assistant, Department of Ophthalmology, Rush Medical College. Author of *A Probable Metastatic Hypernephroma of the Choroid.*

C. S.—Charles Sheard, A. B., A. M., Ph. D.,

Director and Professor of Applied Optics, The Ohio State University. Author of brochure, *Dynamic Ocular Tests; Ocular Accommodation* (in preparation): also articles and researches on "*Mathematical Studies in Optics,*" "*Some Applications of Theoretical to Visual Optics,*" "*Dioptric Formulæ for Cylindrical Lenses Combined at Oblique Axes,*" together with various original researches in physical and physiologic optics, the electron theory and electric oscillations.

D. C. Mc.—Douglas C. McMurtrie, New York City.

Editor *American Journal of Care for Cripples;* former Secretary, American Association for the Conservation of Vision; Author of *Education of and Occupations for the Blind* in the *Reference Handbook of the Medical Sciences.*

D. H.—D'Orsay Hecht, M. D. (Deceased).

D. T. V.—Derrick T. Vail, M. D., F. A. C. S., Cincinnati, Ohio.

Emeritus Professor of Ophthalmology, College of Medicine, University of Cincinnati; Consulting Ophthalmologist, Cincinnati General Hospital; Member American Ophthalmological Society; Ex-president American Academy of Ophthalmology and Oto-Laryngology; Foundation Member, Oxford (England) Ophthalmological Congress; Member Chicago Ophthalmological Society, American Medical Association, etc. Author of *A Detailed and Illustrated Description of Smith's Cataract Operation; Detachment of the Retina and a New Theory; Optic Neuritis from Intra-Nasal Disease; Squirrel Plague Conjunctivitis; Newer Principles in Dealing with Uncomplicated Cataract,* etc.

D. W. G.—Duff Warren Greene, M. A., M. S., M. D. (Deceased).

E. C. B.—Edward C. Bull, Pasadena, Calif.

E. C. E.—EDWARD COLEMAN ELLETT, B. A., M. D., MEMPHIS, TENN.
Professor of Ophthalmology, University of Tennessee, College of Medicine.

E. E. I.—ERNEST E. IRONS, M. D., PH. D., CHICAGO, ILL.
Assistant Professor of Medicine, Rush Medical College; Assistant Attending Physician, Presbyterian Hospital; Attending Physician, Cook County Hospital; Consulting Physician, Durand Hospital of the Memorial Institute for Infectious Diseases, Chicago.

E. H.—EMORY HILL, A. B., M. D., CHICAGO, ILL.
Late House Surgeon, Wills Eye Hospital, Philadelphia; Assistant in Ophthalmology, Rush Medical College (in affiliation with the University of Chicago); Assistant Ophthalmologist to the out-patient department of the Children's Memorial Hospital, Chicago; Assistant Instructor in Ophthalmology, Chicago Polyclinic. Member of American Academy of Ophthalmology and Oto-Laryngology.

E. J.—EDWARD JACKSON, C. E., M. A., M. D., DENVER, COLO.
Professor of Ophthalmology in the University of Colorado; Former Chairman of the Section on Ophthalmology of the American Medical Association; Former President of the American Academy of Ophthalmology and Oto-Laryngology; The American Ophthalmological Society, and The American Academy of Medicine. Author of *Skiascopy and its Practical Application; Manual of Diseases of the Eye.*

E. K. F.—EPHRAIM KIRKPATRICK FINDLAY, M. D., C. M., CHICAGO, ILL.
Assistant Clinical Professor of Ophthalmology, Medical Department, University of Illinois; Assistant Surgeon of the Illinois Charitable Eye and Ear Infirmary; Assistant Oculist at the University Hospital.

E. S. T.—EDGAR STEINER THOMSON, M. D., NEW YORK CITY, N. Y.
Surgeon and Pathologist, Manhattan Eye, Ear and Throat Hospital; Professor of Ophthalmology, New York Polyclinic Medical School and Hospital; Consulting Ophthalmologist to Perth Amboy and Ossining Hospitals; Member of the New York Academy of Medicine, New York Ophthalmological, and American Ophthalmological Societies. Author of *Electric Appliances and Their Use in Ophthalmic Surgery*, in Wood's *System of Ophthalmic Operations*, and various monographs.

F. A.—FRANK ALLPORT, M. D., LL. D., CHICAGO, ILL.
Ex-Professor, Ophthalmology and Otology, Minnesota State University; Ex President, Minnesota State Medical Society; Ex-Chairman and Secretary, Ophthalmic Section, American Medical Association; Ex-Professor, Ophthalmology and Otology, Northwestern University Medical School; Ex-President, Chicago Ophthalmological Society. Author of *The Eye and Its Care;* Co-Author of *An American Text-Book of Diseases of the Eye, Ear, Nose and Throat; A System of Ophthalmic Therapeutics*, and *A System of Ophthalmic Operations.* Eye and Ear Surgeon to the Chicago Board of Education and to St. Luke's Hospital, Chicago.

F. C. T.—FRANK C. TODD, D. D. S., M. D., F. A. C. S. (DECEASED).

F. E. B.—FRANK E. BRAWLEY, PH. G., M. D., CHICAGO, ILL.
Co-Author of *Commoner Diseases of the Eye, A System of Ophthalmic Therapeutics* and *A System of Ophthalmic Operations;* formerly voluntary assistant in the Universitaets Augenklinik, Breslau, and the Royal London Ophthalmic Hospital (Moorfields); Oculist and Aurist to St. Luke's Hospital, Chicago.

F. P. L.—FRANCIS PARK LEWIS, M. D., BUFFALO, N. Y.
President American Association for the Conservation of Vision; President Board of Trustees N. Y. State School for the Blind; President N. Y. State

Commissions for the Blind (1903 and 1906); Chairman Committee on Prevention of Blindness, American Medical Association; Ophthalmologist Buffalo State Hospital and Buffalo Homeopathic Hospital; Consulting Ophthalmologist J. N. Adam Memorial Hospital; Fellow Academy Ophthalmology and Oto-Laryngology.

G. C. C.—See *G. C. S.*

G. C. S.—G. C. Savage, M. D., Nashville, Tenn.

Professor of Ophthalmology in the Medical Department of Vanderbilt University; Ex-President of the Nashville Academy of Medicine; Ex-President of the Tennessee State Medical Society. Author of *New Truths in Ophthalmology* and *Ophthalmic Myology.*

G. F. L.—George Franklin Libby, M. D., Oph. D., Denver, Colorado.

Ex-Assistant Surgeon to the Maine Eye and Ear Infirmary; Ophthalmologist to National Jewish Hospital for Consumptives, Mercy Hospital, and Children's Hospital, Denver; and Denver, Laramie and North Western Railroad; Member of the American Ophthalmological Society, Academy of Ophthalmology and Oto-Laryngology, and Colorado Ophthalmological Society (its Secretary for six years); Author of *Monocular Blindness of Fifty Years' Duration: Restoration of Vision Following Hemiplegia; Polyps in the Lower Canaliculus; Silver Salts in Ocular Therapeutics; Ocular Disease in Relation to Nasal Obstruction and Empyema of the Accessory Sinuses (Bibl.); A Case of Complete Albinism: Observations on the Changes in the Diameters of the Lens as Seen through the Iris; Consanguinity in Relation to Ocular Disease; Heredity in Relation to the Eye (doctorate thesis, Univ. of Colo., 1913); Acquired Symmetrical Opacities of the Cornea of Unusual Type; Tuberculosis of the Bulbar Conjunctiva,* etc.

G. H. P.—Geo. H. Price, B. E., M. S., M. D., Nashville, Tenn.

Professor Ophthalmology Vanderbilt School of Medicine; Ex-President, Nashville Academy of Medicine; Ex-President, Middle Tennessee Medical Society; Ex-Secretary, Tenn. State Medical Association; Ex-Editor, *Journal Tenn. State Medical Association;* Member American Medical Association; Member Southern Medical Association.

H. B. C.—H. Beckles Chandler, C. M., M. D., Boston, Mass.

Professor Ophthalmology, Tufts Medical School, Boston; Senior Surgeon Massachusetts Charitable Eye and Ear Infirmary.

H. B. W.—Henry Baldwin Ward, A. B., A. M., Ph. D., Champaign, Ill.

Professor of Zoology, University of Illinois; Ex-Dean of the College of Medicine, University of Nebraska. Author of *Parasitic Worms of Man and the Domestic Animals; Data for the Determination of Human Entozoa; Iconographia Parasitorum Hominis; Human Parasites in North America.*

H. F. H.—Howard F. Hansell, A. M., M. D., Philadelphia, Pa.

Professor of Ophthalmology, Jefferson Medical College; Emeritus Professor Diseases of the Eye, Philadelphia Polyclinic Hospital; Ophthalmologist to Jefferson Medical College Hospital; Ophthalmologist to Philadelphia Hospital.

H. G. L.—Henry Glover Langworthy, M. D., Dubuque, Iowa.

Surgeon to the Langworthy Eye, Ear, Nose and Throat Infirmary, Dubuque, Iowa; Member American Academy of Ophthalmology and Oto-Laryngology; of the Chicago Ophthalmological Society; of the American Medical Association, etc. Writer of numerous monographs on the special subjects of eye, ear, nose and throat.

H. McI. M.—Howard McI. Morton, M. S., M. D., Minneapolis, Minn.

Senior Surgeon to the Wells Memorial Eye Clinic; Ophthalmic Surgeon to the Swedish Hospital; Ex-President Minnesota Academy of Ophthalmology and Oto-Laryngology.

H. S. G.—Harry Searls Gradle, A. B., M. D., Chicago, Ill.
Professor of Ophthalmology, Chicago Eye and Ear College; Director of Ophthalmic Clinic, West Side Free Dispensary; Member of the Ophthalmologische Gesellschaft, American Medical Association, American Academy of Ophthalmology and Oto-Laryngology.

H. V. W.—Harry Vanderbilt Würdemann, M. D., Seattle, Wash.
Member American Medical Association; Ex-Chairman Section on Ophthalmology, American Medical Association; Hon. Member, Sociedad Cientifica, Mexico; N. W. Wisconsin Medical Society and Philosophical Society. Fellow American Academy of Ophthalmology and Oto-Laryngology. Author of *Visual Economics* (1901); *Injuries to the Eye* (1912); *Bright's Disease and the Eye* (1912); and numerous monographs on the eye and its diseases. Collaborator on many other scientific books.

J. D. L.—Joseph D. Lewis, A. M., M. D., Minneapolis, Minn.
Ophthalmic and Aural Surgeon to the Minneapolis City Hospital; Consulting Ophthalmic and Aural Surgeon to Hopewell Hospital and Visiting Nurses' Association; Member Minnesota Academy of Ophthalmology and Oto-Laryngology; Fellow American College of Surgeons.

J. G., Jr.—John Green, Jr., A. B., M. D., St. Louis, Mo.
Assistant in Ophthalmology, Washington University Medical School; Ophthalmic Surgeon to St. Louis Children's Hospital; Ophthalmic Surgeon to St. Louis Eye, Ear, Nose and Throat Infirmary; Consulting Ophthalmic Surgeon to St. Louis Maternity Hospital; Consulting Ophthalmic Surgeon to St. John's Hospital, St. Louis.

J. L. M.—John L. Moffat (Deceased).

J. M. B.—James Moores Ball, M. D., LL. D., St. Louis, Mo.
Dean and Professor of Ophthalmology, American Medical College of St. Louis, Medical Department of National University of Arts and Sciences. Author of *Modern Ophthalmology; Andreas Vesalius the Reformer of Anatomy.*

J. R. C.—James Raley Cravath, B. S., Chicago, Ill.
Electrical and Illuminating Engineer, Chicago; Vice-President, Illuminating Engineering Society; formerly associate editor *Electrical World;* joint author *Practical Illumination* by Cravath and Lansingh; joint author *Light—Its Use and Misuse,* prepared by committee of the Illuminating Engineering Society; author of *Illumination and Vision; Tests of the Lighting of a Small Room;* and numerous other monographs.

L. H.—Lucien Howe, M. A., M. D., Sc. D., Buffalo, N. Y.
Professor of Ophthalmology, University of Buffalo; Member of the Royal College of Surgeons of England; Fellow of the Royal Society of Medicine; Member of the *Ophthalmologische Gesellschaft* and of the *Société Française d'Ophthalmologie.* Author of *The Muscles of the Eye.*

L. M.—Lloyd Mills, M. D., Los Angeles, Cal.
Late Voluntary Assistant II Eye and I Surgical Services *(Abteilung Budinger)* Vienna General Hospital.

M. S.—Myles Standish, A. M., M. D., S. D., Boston, Mass.
Williams Professor of Ophthalmology, Harvard University; Consulting Ophthalmic Surgeon, Massachusetts Charitable Eye and Ear Infirmary and Carney Hospital, Boston, Mass.

N. M. B.—Nelson M. Black, Ph. G., M. D., Milwaukee, Wis.
Author of *The Development of the Fusion Center in the Treatment of Strabismus; Examination of the Eyes of Transportation Employes; Artificial Illumination a Factor in Ocular Discomfort,* and other scientific papers.

P. A. C.—Peter A. Callan, M. D., New York City, N. Y.
Surgeon, New York Eye and Ear Infirmary; Ophthalmologist to St. Vincent's Hospital; Columbus Hospital and St. Joseph's Hospital, New York.

P. G.—Paul Guilford, M. D. (Deceased).

R. D. P.—Robert D. Pettet, Chicago, Ill.
Author of *The Mechanics of Fitting Glasses.*

S. H. McK.—Samuel Hanford McKee, B. A., M. D., Montreal, Que.
Lecturer in Pathology and Bacteriology, McGill University; Demonstrator in Ophthalmology, McGill University; Assistant Oculist and Aurist to the Montreal General Hospital; Oculist to the Montreal Maternity Hospital; Oculist to the Alexandra Hospital; Member of The American Association of Pathologists and Bacteriologists. Author of *The Bacteriology of Conjunctivitis; An Analysis of Three Hundred Cases of Morax-Axenfeld Conjunctivitis; Demonstration of the Spirocheta Pallida from a Mucous Patch of the Conjunctiva; The Pathological Histology of Trachoma,* and numerous other monographs.

T. A. W.—Thomas A. Woodruff, M. D., C. M., L. R. C. P.
Ex-President of Chicago Ophthalmological Society; Vice-President of the Illinois Society for the Prevention of Blindness; Fellow of A. M. A.; Fellow American Academy of Medicine; Fellow of American Academy of Ophthalmology; Fellow American College of Surgeons; Fellow of the Institute of Medicine of Chicago; Member of Chicago Society of Medical History; Chicago Medical Society; Author with Casey A. Wood of *Commoner Diseases of the Eye;* Formerly Ophthalmic Surgeon to St. Luke's Hospital.

T. H. S.—Thomas Hall Shastid, A. B., A. M., M. D., LL. B., F. A. C. S., Superior, Wis.
Honorary Professor of the History of Medicine in the American Medical College, St. Louis, Mo.; Author of *A Country Doctor; Practising in Pike; Forensic Relations of Ophthalmic Surgery* (In Wood's *System of Ophthalmic Operations); Legal Relations of Ophthalmology* (in Ball's *Modern Ophthalmology); A History of Medical Jurisprudence in America* (in Kelly's *Cyclopedia of American Medical Biography).*

W. C. P.—Wm. Campbell Posey, B. A., M. D., Philadelphia, Pa.
Professor of Ophthalmology in the Philadelphia Polyclinic Hospital and Graduate Medical School; Ophthalmic Surgeon to the Wills, Howard and Children's Hospitals; Chairman of the Pennsylvania Commission for the Conservation of Vision; Chairman of Section on Ophthalmology, College of Physicians, Philadelphia. Editor of American Edition of Nettleship's *Textbook of Ophthalmology;* Co-Editor, with Jonathan Wright, of *System of Diseases of the Eye, Ear, Nose and Throat;* Co-Editor, with Wm. G. Spiller, of *The Eye and the Nervous System.*

W. F. C.—W. Franklin Coleman (Deceased).

W. F. H.—William Frederic Hardy, M. D., St. Louis, Mo.
Assistant in Ophthalmology, Washington University Medical School.

W. T. S.—William T. Shoemaker, M. D., Philadelphia, Pa.
Clinical Professor of Ophthalmology, Women's Medical College of Pennsylvania; Ophthalmic Surgeon to the Laukenau, Germantown, and Pennsylvania Hospitals; Consulting Ophthalmologist to the Pennsylvania Institution for Deaf and Dumb, Mt. Airy; Southern Home for Destitute Children, and Home for Training in Speech of Deaf Children, Bala, Pennsylvania. Chairman of Section on Ophthalmology, College of Physicians, Philadelphia, 1917-18-19.

Retina, Detachment of the. Separation of the retina. Dislocation of the retina. Amotio retinæ. Sublatio retinæ. In addition to the subsection devoted to this subject under **Retina, Injuries of the,** brief discussions of this heading will be found in various captions of this *Encyclopedia*. See, for example, **Detached choroid,** p. 3857, Vol. V; **Myopia, Progressive,** p. 8275, Vol. XI; and **Cataract, Senile,** p. 1740, Vol. III. Much of the following has also appeared in the Editor's chapter XII, p. 1349, Vol. II of his *System of Ophthalmic Operations*.

Owing to the length and importance of this introductory matter, a table of contents giving the sub-sections in their order here follows.

Historical review, early recognition of detached retina and of operations for its relief—Surgical pathology of and anatomical changes in detached and reattached retina—Causes of detachment of the retina—Frequency of retinal separation—Relations of reattachment of the retina to central and peripheral vision—Prognosis in operative treatment—What constitutes a cure of retinal detachment?—Relapses in the course of operative treatment—Spontaneous reattachment of separated retina—Supplementary (non-operative) measures—Simple scleral or sclero-choroidal puncture—Posterior sclerotomy—Paracentesis of the sclera—Posterior ophthalmotomy—Iridectomy in detachment of the retina—Puncture or incision of the detached retina itself—Dislaceration with two needles—Aspiration of the subretinal fluid—Permanent drainage of the subretinal sac—Drainage with a gold thread—Attachment of the displaced retina to a scleral wound—Puncture of the eyeball with the galvanocautery—Subconjunctival injections—Galvanocautery of the sclera—Suturing the separated retina to the choroid and sclera—Electrolysis of the post-retinal fluid—Induction of labor in the treatment of ablatio retinæ due to the albuminuria of pregnancy—Mueller's operation—Deutschmann's operations—Bisection, with and without the intravitreous injection of sterile animal vitreous—Lang's operation—Vertical incision through the sclera—Wolfe's operation—Discission of vitreous membranes in connection with retinal detachment—Punctiform cauterization—Extensive longitudinal incisions of the sclera—Iodine injections into the subretinal sac only—Summary.

The early recognition of detached retina and the first operations for its relief. Whether or not Saint-Yves (1722), Morgagni (1740), Wardrop (1818), and Panizza (1828) fully appreciated the condition later described as amotio sive sublatio retinæ, there can be no doubt that some of the findings referred to by them, as hydrops sub-

choriodealis and hydrops chorioideæ internus were genuine examples of detachment of the retina.

James Wardrop *(The Morbid Anatomy of the Human Eye.* Vol. II., pp. 71 and 291, Second Edition, 1834) certainly gives a definite clinical and anatomical picture of the disease. "I have," says he, "had an opportunity of dissecting several eyes where a serous fluid had collected between the Choroid Coat and Retina. In these cases, the retina and vitreous humor were displaced and compressed by the morbid collection of water; the vitreous humor being more or less absorbed, while the retina was shriveled up, and formed a white bundle, extending through the center of the eyeball, from the entrance of the optic nerve to the posterior part of the crystalline capsule. The choroid coat was unchanged."

His Plate xvii. plainly shows the retinal detachment exactly as described.

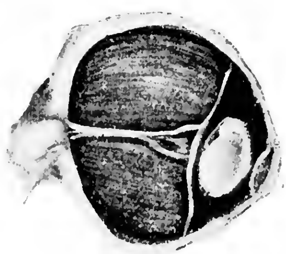
That William Mackenzie (*A Practical Treatise on the Diseases of the Eye*, London, 1830, p. 460. See, also, the American Edition of 1855; pp. 506, 507 and 510) was well acquainted both with the pupillary and anatomical appearance of detachment of the retina and the need for surgical interference in its treatment, is quite evident from a perusal of both his earliest and his later text-books. He says, inter alia, "It has been ascertained by dissection that a watery fluid is sometimes present in sclerotic staphyloma between the sclerotica and the choroid, whereby the latter tunic is pressed inwards and the former outwards. There are also good grounds for believing that a similar effusion forms occasionally between the choroid and the retina. If the fluid collected in the latter situation is not evacuated by puncturing the staphyloma, it may accumulate to such a degree as to press the retina before it, and having at last produced, by means of its continued pressure, an absorption of the vitreous humor, it will gather the retina into a cord, as sometimes happens in arthritic and in mismanaged cases of syphilitic ophthalmia. A third situation of the hydrophthalmic effusion is between the retina and the hyaloid. Perhaps within the hyaloid is as frequent a seat of the watery effusion as any other; and in this case the structure of the vitreous body is broken up and dissolved."

"Puncturing the sclerotica and choroid, so as to evacuate the fluid collected within the eye, is a remedy of much importance in the treatment of this disease. The operation is performed with the extraction-knife or with a broad cataract needle, thrust, not in the direction of the lens, which it might readily wound, and render opaque, but towards the center of the vitreous humor. The instrument need not

penetrate deeper than the eighth of an inch. A little blood is usually discharged, along with aqueous fluid of a slightly glutinous consistence. It may be repeated every eight days, or at longer intervals, according to the state of the eye."

Under the caption, "Sub-choroid Dropsy," Mackenzie gives in full (p. 663, American Edition) the history of a case operated on by James Ware, to which further reference will be made when speaking of scleral puncture.

Mackenzie says that in "suspected cases of sub-choroid hydrophthalmia, there can be no doubt of the propriety of following the practice of Mr. Ware, and puncturing the eye at the usual place of passing the cataract needle through the sclerotica and choroid. Mr. Ware recommended a grooved needle for this purpose, so that the fluid might more certainly escape; but a better plan is, to puncture with a broad cataract needle, or the point of the extraction knife, and then hold the edges of the wound apart by means of a small probe. Care



Total Detachment of the Retina. Calcareous Lens. (Würdemann.)

should be taken in making the puncture to direct the point of the instrument, so that it may not wound the posterior part of the crystalline capsule. The operation may be repeated from time to time, should the symptoms seem to demand it."

Following the invention of the opthalmoscope in 1851 the fundus appearances of retinal separation were accurately pictured by Coccius, *(Ueber die Anwendung des Augenspiegels,* 1853.) while von Graefe (*Archiv. f. Ophthal.*, Vol. I, 1854, p. 362, and in several subsequent volumes.) shortly afterwards (1854) gave us as complete a description of the disease in all its aspects as one finds in any modern text-book.

These definite clinical, pathological and ophthalmoscopical researches were followed in the fulness of time by attempts to replace the separated membrane through the employment of remedies mostly operative. It is with these efforts, extending over half a century, that we shall shortly deal.

Surgical pathology of and anatomical changes in detached and re-attached retina. Leber, Nordenson and other observers have noticed a rent or rents in the separated membrane.

Nordenson (*Die Netzhautablösung,* Wiesbaden, 1887) saw these lacerations in more than one-third of the 119 cases he examined, and located the primary lesion in the choroid and ciliary body. A uveitis sets in that is followed by fibrillary metamorphosis and consequent shrinking of the vitreous body. The vitreous becomes firmly attached to the retina and in contracting not only detaches the latter from its choroidal bed, but tears it, producing the rents just referred to. Through these openings, often quite minute, the post-hyaloid effusion passes. If the detachment occurs, as it generally does, in the upper part of the globe, the fluid gravitates downward and further tends to increase the detachment.

The effect of detachment upon the retinal elements is, of course, disastrous. The light and form perceiving elements suffer to some extent at once and this defect is further increased by prolonged deprivation of the nutriment which the retina derives from the underlying ciliary and choroidal vessels.

Leber divided detached retina into three categories, depending mostly upon the histological conditions. A. Shrinking of the vitreous body; outpouring of a preretinal fluid which, through a tear or tears in the retina, passes behind the latter and gradually forms a serous sac. This might be styled the acute form of separation of the retina. B. In chronic cases of retinal detachment shrinking of the vitreous body takes place without tears in the retina and without fluid passing from the posterior chamber behind the retina. C. That form of detachment that occurs with cyclitis, when there is a fibrinous exudate that eventually ends in vitreous shrinking.

This is not the place to enlarge upon the dozen or more additional theories that have been put forward by various observers during the last sixty years to account for various forms of this disease. It might, however, be mentioned that disease of the choroid itself offers an explanation of some cases of amotio retinæ.

deSchweinitz and Shumway (*Trans. Am. Oph. Soc.,* 1901, p. 283) have particularly drawn attention to the presence of cystic degeneration of the choroid in retinal detachment and there seems no good reason why a metamorphosis that weakens the union between the retina and choroid might not at least predispose to a detachment of the former.

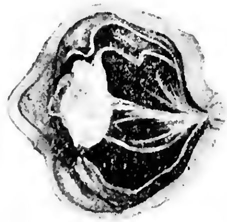
Uhthoff (*Bericht der Ophthalmologischen Gesellschaft,* 1903, p. 4) with a demonstration of the preparation on page 270, of the same

has described the retinal and choroidal changes in a case of spontaneous reattachment of the separated retina of a bilateral retinitis albuminurica. Raehlmann believes that various influences may produce alterations in the choroid followed by a serous or even solid exudation which, accumulating, pushes the retina before it, forming the so-called post-retinal sac. The contents of the sac may or may

Detachment of Retina. (Würdemann.)

not, in time, communicate with the hyaloid chamber by way of openings in the retina.

Causes of detachment of the retina. No rational treatment—medical or surgical—can be undertaken without a fairly definite idea of the causation of this disease. Without going too deeply into the subject it may be said that the affection is most common in men between the ages of 44 and 60. The chief exciting causes are those



Detachment of the Retina and Choroid. Atrophia Bulbi. (Würdemann.)

agencies that increase intraocular strain, such as lifting heavy weights, stooping, vomiting, constipation, childbirth, sneezing, severe injuries to the globe or its neighborhood, etc.

A table, representing an investigation of 300 cases of separation of the retina examined in Horner's klinik, furnishes a satisfactory clinical index of its pathogenesis, especially of the predisposing causes:—

Myopia	144	cases	48 per cent.
Injury	49	”	16.3 per cent.
Iritis, uveitis	11	”	3.6 per cent.
Choroiditis	10	”	3.3 per cent.
Hemorrhagic diathesis	23	”	7.6 per cent.
Congenital anomalies	2	”	0.6 per cent.
Congestive causes	11	”	3.6 per cent.
Opacities of the vitreous alone	22	”	7.2 per cent.
Idiopathic detachments	28	”	9.3 per cent.
	300	”	100 per cent.

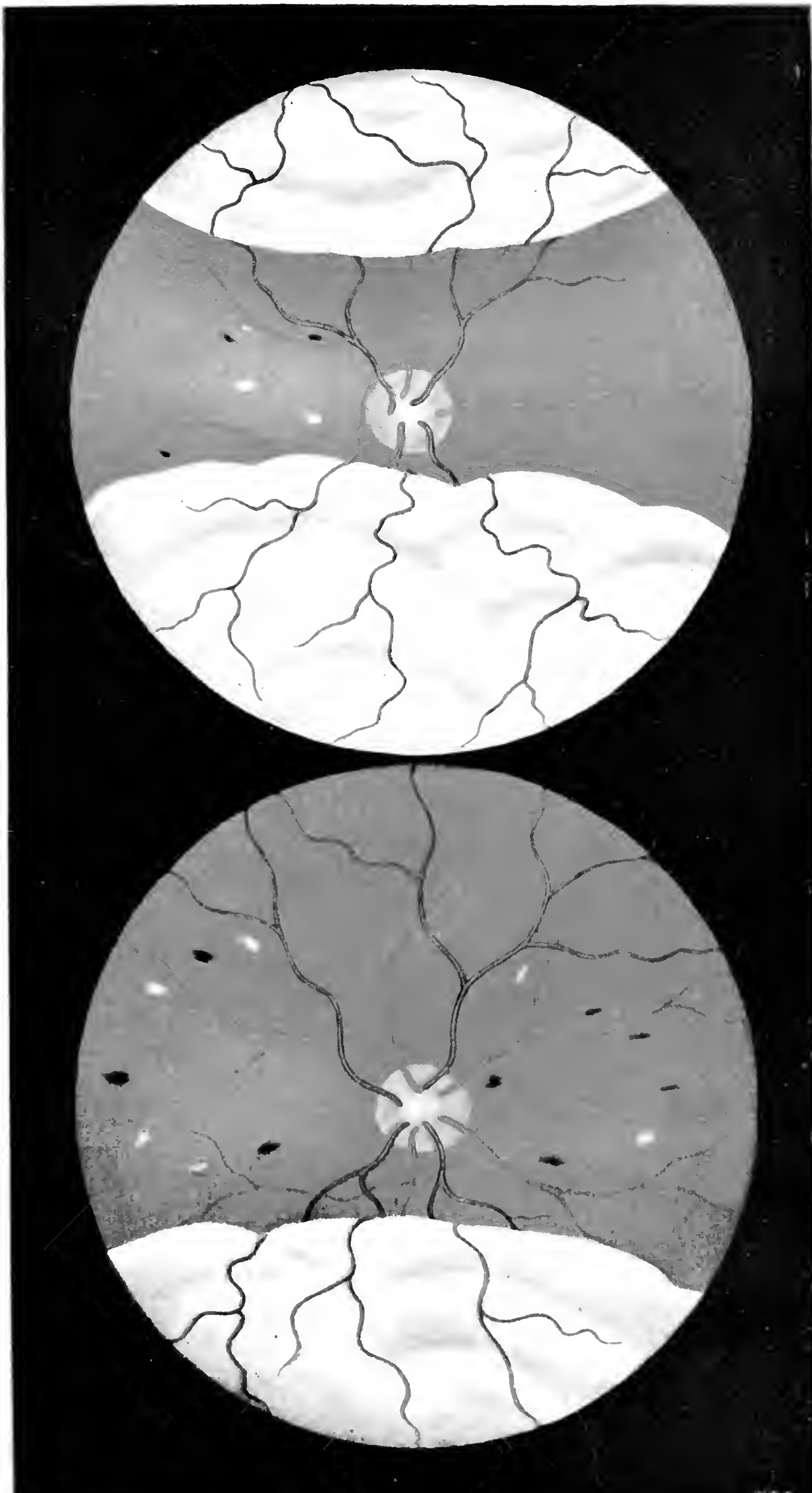
Tumors of the retina and choroid, as well as solid or semi-solid post-retinal exudates, are, of course, not included in this table, while a few instances of albuminuric retinitis are included under "hemorrhagic diathesis."

Detachment of the retina during pregnancy. Schiøtz (*Norsk. Mag. for Lægevid.* Vol. 80, April, 1919; abs. *Journ. Am. Med. Assocn.*, June 14, 1919) reports three cases of detachment of the retina during pregnancy nephritis. Each patient was a primipara 17, 29 or 35 years old, all with albuminuria and eclampsia, but without pronounced edema. They were all emmetropic, and detachment of the retina occurred after several convulsions, bilateral detachment in the older woman. In this case it occurred at the seventh month and persisted for a month after the miscarriage, but then the retina returned to its place, with vision of 6/36 and 6/6. There was evidently pregnancy nephritis in this case, and albuminuria returned at a second pregnancy five years later, but it disappeared after spontaneous abortion at the seventh month. Vision was not affected this time. In the second patient there was also retinitis and detachment of the retina which persisted for two weeks until delivery (seventh month); then the retina returned to place at once and in two days there was no further trace of the detachment. The youngest patient developed the eclampsia after delivery at term, and the detachment of the retina occurred without any signs of retinitis, only papillitis. The detachment of the retina has persisted unmodified in this case during the year since to date of publication.

In a fourth case the detachment of the retina occurred during the fourth pregnancy of a myopic woman, otherwise normal. The eye affected became totally blind, and in the other eye detachment of the retina occurred likewise just before term in the fifth pregnancy. There was no trace of albumin or sugar in the urine. A Müller *scleral exci-*

A

B



Detachment of the Retina [illegible]

sion (q. v.) was done on the right eye, just before delivery, and within a week the retina had returned to place, but vision was only 2/36, and after a few months this declined. Schiøtz knows of only four similar cases on record of detachment of the retina in pregnant women without a trace of albuminuria; three of the total five were strongly myopic. The detachment persisted unmodified in all but one case. In two of the other cases, the retina in the other eye became detached at the fourth or sixth month of a later pregnancy. But artificial delivery at once in both cases was followed by the restoration to place of the retina, with recovery of reading vision. All these cases seem to teach that the longer the interval between the detachment of the retina and the delivery, the smaller the chance of restoration of the retina to place. Consequently it is extremely important to interrupt the pregnancy at once.

Albuminuric retinitis (the *gravidic* as well as the purely renal and cerebral forms) as a cause of detached retina is fully discussed under **Retinitis albuminurica.** The anatomical appearances of the retina are fully considered under the various headings (q. v.) proper to all the diseased conditions that produce or accompany the separation.

G. S. Derby (*Am. Journ. of Ophthalm.*, p. 199, March, 1919) records a case of double detachment of the retina in a trench nephritis.

C. A. Clapp (*Am. Journ. of Ophthalm.*, p. 473, July, 1919) contributes a masterly and well illustrated essay on this subject. He finds that *retinal detachment in eclampsia* is, according to most authors, a very rare condition and conspicuous by a paucity of literature. Six such cases have been under the writer's observation since December, 1917, varying in extent from small to almost complete detachment of the retina. In contradistinction to so-called idiopathic detachments, these have all subsided and become reattached with normal fields of vision.

They may be antepartum or postpartum, and may clear up in a few hours, and are frequently far forward in the periphery and found only after some searching. They are probably present much more frequently than heretofore recorded, and the prognosis is good so far as the detachment is concerned.

Frequency of retinal separation. Sattler (*Deutsch. Med. Wochenschr.*, 1905, 1 and 2) asserts that detachment of the retina occurs five or six times in every 1,000 cases of ocular disease and that about 8 per cent. of these are bilateral.

These figures, it must be remembered, refer to Germany where patients with high degrees of myopia (the commonest predisposing

cause of the affection) are more frequently seen than in this country.

Its frequency in France may be estimated from a report (*Bulletins de la Soc. Francaise d'Ophtal.*, 1887, p. 67) of a committee of the *Société Française d'Ophtalmologie* involving 67,464 eye patients; 416 exhibited separation of the retina.

Relations of reattachment of the retina to central and peripheral vision. The diminished visual acuity and the lateral defects in the field of vision noticeable to the patient are, as a rule, much improved when the separated membrane is restored to its normal position. Still, this result cannot always be counted on and its possibility or probability should be considered both by the patient and the surgeon before resort to operative procedures.

It is not rational to suppose, when the percipient elements of the retina are from any cause seriously damaged, the optic nerve the seat of disease, or the ocular media cloudy, that a reattachment, however perfect, can *per se*, be of much value to the patient. Such a situation followed by a reattachment Hirschberg calls "anatomische Heilung," because the result is purely mechanical and has nothing to do with the visual function. The post-operative condition in such cases is paralleled when a mature cataract is extracted in a case of advanced retinitis pigmentosa; the operation may succeed but the hemerolope is not much better off, *quoad visum*, than he was before the operation. The possible improvement in eye-sight may, fortunately, be closely estimated from the history of the case, by testing the projection, by the use of the perimeter and by ophthalmoscopy. In any event it is wise to take a conservative view of the whole situation; it is better to promise too little than too much.

Prognosis in operative treatment. Even under favorable conditions permanent cures of this formidable disease call for the exercise of much patience and endurance both by the surgeon and the sufferer. Even then the outcome is at least doubtful. One can, however, usually give a fairly definite reply to anxious enquirers after fully considering the causes, character, extent, duration and the coincident ocular changes of a particular example of retinal separation.

In a general way it may be said that, as Sattler tersely puts it, *the smaller the detachment and the more recent the case the more encouraging the prospect.*

Schöler (*Zur Operative Behandlung der Netzhautablösung,* Berlin, 1889) found in his experience that the cases most successfully treated are recent, and present a clear vitreous and a bagging of the detached retina, thus indicating the presence of a small quantity of sub-retinal fluid. He regarded as unfavorable, concomitant disease of the media,

especially a fluid and turbid vitreous, high myopia, extensive detachment of the retina and marked disease of the choroid.

In considering the propriety of submitting the patient to surgical measures it must not be forgotten that the Committee of the Société Française ended their report on all operations known to them at that time with these words: "Since we cannot affirm the certainty of *any* operative measure it may be stated that, *as a rule,* it is good policy to abstain from *any* surgical interference in the treatment of detached retina." However, we are, at the present time, able to take a somewhat more encouraging view of the situation.

What constitutes a cure of retinal detachment? In the Editor's experience of this affection the patient is generally satisfied with useful central vision and the permanent disappearance of the lateral cloud in his visual field, even if the reattachment is incomplete. On the other hand, even if there is a satisfactory "anatomical cure," from the surgeon's standpoint the sufferer is, of course, not interested in that fact when his eyesight is not distinctly improved as a result of the treatment.

That a patient with detached retina may be spoken of as cured, the reattachment should be complete, or so nearly complete that he does not complain of symptoms, and the retina have retained its normal position for at least a year.

Relapses in the course of operative treatment. The hopes of both patient and surgeon are often doomed to disappointment because of secondary detachment of the replaced retina. It quite frequently happens that, after a complete reposition of the separated membrane (with demonstrable increase in both central and peripheral vision lasting for a considerable time), the retina is once more torn away from the choroid. This accident, due to various causes, has, in many instances, taken place while the patient was quietly lying in bed, under atropia and wearing a bandage.

A ray of comfort and hope is thrown upon this discouraging fact in the surgical conduct of separated retina in that quite a number of brilliant and permanent cures have followed persistent treatment and the repetition of operations, in spite of these relapses. It is desirable, therefore, in the preliminary discussion with the patient of the "pros and cons" of proposed operative measures that this irregular course of the disease be frankly stated. No surgical intervention should be undertaken unless all parties to it are willing to have the patient submit to repeated operations as long as there is a chance of recovery. Deutschmann, for example, has finally succeeded in several cases of relapse, after operating a dozen times or more.

Spontaneous reattachment of separated retina. Instances of this happy event which Hirschberg calls "physiologische Heilung," have been reported by many observers, although authors greatly vary in estimating their frequency.

Deutschmann, in 300 cases, saw three spontaneous recoveries, or 1 per cent., Hirschberg four examples in 338, while Uhthoff reports a much higher proportion—28 cases out of 337—about 8.30 per cent.

Milliken reports a case of detachment of the retina, confined to the macular region, occurring in a fairly healthy man, that resulted in practical recovery without treatment.

H. M. Post (*Amer. Jour. of Ophth.,* May, 1907, p. 129) gives a history of two cases, in one of which the retina resumed its proper position while the patient was in bed waiting for the removal of a cataract in the other eye. In another patient the reattachment occurred wihout any known cause and without treatment.

This subject is exhaustively discussed by Müglich (*Inaugural Dissertation,* Marburg, 1891) and later by Spämer (*Inaugural Dissertation,* Breslau, 1904) in the light of case-histories from Uhthoff's clinics in Marburg and Breslau. In a number of these cases there remained slight defects in the visual field or small areas of unattached or imperfectly attached retina, not noticed by the patient.

In some instances, however, the period of observation (less than a year) was not protracted enough to assure oneself that a return of the separation might not take place. One may place in the category of "physiological" cures quite a number of replacements thought to be due to rest in bed, sweats, dionin, mercurials, iodides, and other kinds of medical treatment, not to mention those following minor surgical interferences—subconjunctival injections, cauterization of the sclera, and the like. In any event, Müglich gives the histories of 136 published cases (1891) of detached retina in which there was complete replacement of the membrane without resort to any surgical treatment whatever, and these figures by no means exhaust the list to the present time.

Supplementary (non-operative) measures. In all, or nearly all, the forms of surgical intervention about to be described various kinds of medical treatment are also prescribed. It is only fair to add that numerous cures have been claimed for one and all of these non-operative measures alone, as well as for almost any two or three of them combined.

Perhaps the most important remedy is the *prone position in bed* for weeks at a time, varied by daily removals to a couch or lounge. The patient should during the period of rest studiously refrain from

any considerable exertion and must avoid straining at stool, sneezing, hawking, laughing and above all, coughing. During this state of complete relaxation he may, at the discretion of the surgeon, take such supplementary treatment as the case seems to demand.

Many observers combine with this form of "rest cure" the use of the artificial (Heurteloup) leech, atropia, simple protective or compression bandages, tinted glasses, a darkened room, laxatives, sudorifics, a restricted diet and the employment of certain drugs said to have a specific effect upon the vitreous changes, choroidal disease, subretinal effusion and the other accompaniments of the disease.

Freytag (*Munch. Med. Wochenschr.* No. 35, 1907, p. 1734) after considerable experience with the pressure bandage, believes that it is without value in the conduct of cases of detachment of the retina. On the whole, he thinks that the effect is rather harmful than otherwise. He also takes the view, held by a number of observers, that it is more likely that the majority, if not all, of the cures of separation considered to be due to the use of the bandage and similar minor procedures really belong to that rather large class of spontaneous cures. In corroboration of this contention he quotes the statistics of Uhthoff, who observed in 422 cases 36 permanent cures; of these 18 got well without treatment.

The most important of the internal remedies are large doses of potassium iodide, or sodic salicylate (Gifford) combined with sweat baths, with or without pilocarpine.

For example, an interesting account of the treatment of detached retina by means of pilocarpine and sodium salicylate combined is given by Emerson, who has reported encouraging results from the use of these remedies.

Simple scleral or sclero-choroidal puncture. Posterior sclerotomy. Paracentesis of the sclera. Posterior ophthalmotomy. This operation is intended to give vent to the subretinal fluid which, from the earliest years of the ophthalmoscopic era, was known to be an almost constant accompaniment of ablatio retinæ. It was the first rational operation performed for the relief of the disease and was recommended and practiced by James Ware in 1805 and by Sichel, Sr., in 1859. Uhthoff gives priority in the performance of this operation to Kittel. The probability is that the two last-named surgeons employed it about the same time. Von Graefe and von Kries considered it of value, while Schweigger held that in recent cases and when followed by sweat baths, sodium salicylate and a pressure bandage, simple scleral puncture is among the most effective operations for detached retina.

In awarding to James Ware (*Chirurgical Observations Relative to*

the Eye, Vol. II, 1805, pp. 238 and 514) the honor of having done not only the first operation for the relief of detachment of the retina, but also priority for the practice of posterior sclerotomy, we quote his own words: "On making a puncture through the choroidea, about the middle of the space between the rim of the cornea and the entrance of the optic nerve, a yellow colored fluid, as thin as water, immediately escaped through the wound; and on enlarging the incision, the retina was found to be collapsed, and to resemble a cone of a white color, the apex of which was at the entrance of the optic nerve, and its basis round the circumference of the crystalline humor. This humor, which could not now be accurately distinguished from the parts contiguous to it, seemed to adhere to its capsule, and the capsule to the posterior surface of the iris; and there did not appear to remain the smallest vestige of the vitreous humor."

"The operation was attended neither with difficulty nor danger. It consisted simply in the introduction of a common spear-pointed couching needle through the tunica sclerotica, a little further back than the part where it is usually introduced for the purpose of depressing a cataract. As soon as the instrument entered the eye a yellow-colored fluid immediately escaped, sufficient in quantity to wet a common handkerchief quite through. The needle was continued in the eye about a minute, in order to give the fluid a more ready way to come out; and as soon as it was withdrawn the discharge ceased. The tension of the eye was considerably diminished by the operation. A compress dipped in a saturnine lotion was bound upon it, and the patient put to bed."

The proper point of entrance of any cutting instrument intended to reach the retina is best determined by the ophthalmoscope and should, when possible, be so made that the ciliary body and larger bulbar vessels are avoided while directing the knife into the posterior chamber. These small areas are here depicted, and although an aseptic, straight needle, lance or narrow knife can, as a rule, be plunged into almost any sterilized eye at or near the equator without serious risk, yet it is safer to choose, when possible, one of the four regions indicated.

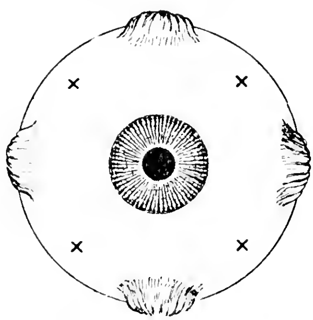
If this rule be followed there is rarely any extensive bleeding and infection to mar the results of the operation.

With more extensive interference with the globar walls and tissues of the ocular interior the danger of these and other complications is, of course, greater, the gravity of the operation depending upon the state of the eye as well as the locality and extent of the wound.

It is not always possible to choose the safest point or area for scleral

punctures or incisions. In the same way one may not have a choice either of the incisional length or direction—whether longitudinal, meridional or oblique, whether 2 mm. or 20 mm. long. Where, however, a selection can be made less damage is done to the ocular walls and there is less danger of serious intraocular hemorrhage if the selected area be between the margins of neighboring straight muscles (See figure) and if the incision or puncture be longitudinal, not too close to the equator, and directed towards the geometrical center of the eyeball. If these precautions can be taken one may steer clear of the lens, the vortex veins and the posterior ciliary vessels.

Scleral puncture seems to hold its own to the present time and alone, or in conjunction with other forms of treatment, is practised more frequently in detached retina than most of the surgical procedures



Simple Sclero-Choroidal Puncture.

Points of Election 8-12 mm. from the Sclero-corneal Junction, between the tendinous insertions of the straight muscles, for bulbar punctures and incisions.

about to be mentioned. Cures following its performance are not uncommon, and, when practised within proper scleral areas, it is practically devoid of danger.

Greenwood, for example, gives an account of a case treated by this means with improvement that was not, however, permanent.

deSchweinitz has had good results with scleral puncture when it is followed by large subconjunctival injections of physiological salt solution (q. v.) and has not found it necessary to increase the strength of the chloride sodium solution beyond 5 per cent. Subsequent to this treatment the patient should remain in bed.

An instance of cure is also reported by W. H. McMullen (*Trans. Ophthal. Soc. U. K.*, Vol. 27, 1907, p. 124). The detachment had persisted for eleven months and after repeated punctures of the sclera, combined with rest in bed and a bandage, the patient entirely recovered.

M. Sachs has made a slight modification in the foregoing method; he makes a small incision behind and parallel to the equator and through it passes a sickle-shaped knife into the eye. In withdrawing the blade it makes a decided incision of the intraocular membranes and so increases the area of cicatricial exudation and subsequent adhesion of the wounded tissues.

Scleral puncture with incision of the detached retina. As early as 1863 von Graefe (*Archiv f. Ophthalmologie,* IX, 2, 1863, p. 85) advised and practised discission of the detached retina, an operation which he performed over fifty times. Only in one instance was this procedure followed by the loss of the eye. In about one-half the cases improvement was observed at once, although better vision was claimed for a year and longer in only four instances.

The operation is a simple one and consists in the passage of a narrow knife, or knife-needle, through the globar walls, behind the ora serrata and, then, through the detached retina.

deWecker, Arlt, Bowman and others gave this procedure a fair trial with occasional good results, but it proved, on the whole, to be so unsatisfactory that it was finally abandoned. In more recent times it has received some support and has had a few advocates.

Dislaceration with two needles. About the year 1863 Bowman (*Ophthalmic Hospital Reports,* No. 19, 1864, p. 133) began to practise upon the detached membrane pretty much the same measures that he employed for discission of secondary cataract—the double-needle operation. He had in mind not merely making a rent in the retina for the purpose of allowing a flow of the subretinal fluid into the vitreous cavity, but the production of an adhesive inflammation between the floating membrane and its choroidal bed.

Aspiration of the subretinal fluid. Long before Erik Nordenson published his classic work on the pathological histology of detached retina the attention of most ophthalmic surgeons had been directed to the sac of post-retinal fluid poured out, it was supposed by the vessels of the choroid or retina, pushing the latter membrane forward and away from its pigment bed. This incident was regarded as the most important surgical fact connected with the disease and it was not strange, therefore, that the surgeon set himself the task of getting rid of it.

For this purpose de Wecker invented a trocar, to be used in tapping the subretinal sac much as one would a dropsical kneejoint; Secondi described his operation of hydrodictyotomy and Galezowski aspirated or suggested the aspiration of the postretinal fluid with a modified Dieulafois' syringe. Weber advised the use of a more complicated

apparatus to accomplish the same end—a double canula and syringe for the dual purpose of aspirating the watery secretion and of injecting an "indifferent fluid" into the vitreous cavity—not only to fill the vacuum but to press back the detached membrane into its proper place. More recently Mooren has claimed good results from simple aspiration of the fluid with an ordinary (Pravaz) hypodermic syringe.

These operative measures, however ingenious, failed, for evident reasons, to produce the expected result and were soon abandoned and forgotten.

Permanent drainage of the subretinal sac. The temporary reduction of the supply of subretinal fluid was quite early seen to be of little use in bringing about a lasting reposition of the separated retina. This observation is responsible for an attempt by de Wecker (*Du drainage de l'oeil.* Thèse de Paris, 1877) (and Grizou) to establish permanent drainage of the subretinal exudation, in the hope that it would be followed by a final return of the retina to its resting place against the choroid. He consequently passed a curved needle, armed with a very fine gold thread, through the scleral wall and the choroid and, making a counter-puncture about a centimeter from the point of entrance, brought it out and tied the two ends over the conjunctiva. As might have been expected this procedure was not only unsuccessful, but the septic wire infected all the ocular structures with which it came in contact and endangered the integrity of the whole eyeball. It has consequently long passed into the limbo of forgotten surgical enterprises.

Mm. Ribard (*Thèse de Paris*, No. 413, 1876, p. 41) gave the results of treating eight cases by this *anse à filtration*. They are not worth serious consideration, although a note is made that there was "tolèrance parfaite" in most of the cases, and the author evidently believed in their efficacy.

Attachment of the displaced retina to a scleral wound. As early as 1871 Meyer, having failed by other operative interferences to replace the retina in a case of detachment, conceived the plan of passing a suture through the membrane and drawing it to an opening in the scleral wall. "Jai eu recours," said he, "á un procédé opératoire tout nouveau et qui consiste à enclaver la portion decollée de la rétine dans une plaie scléroticale" but it does not appear to have appealed to the imagination of other ophthalmic surgeons.

Iridectomy in detachment of the retina. Inasmuch as this popular operation has been called into play in nearly every form of intrabulbar disease it is to be expected that it would be given a trial in retinal separation. It was probably Fano who first (1869) employed

iridectomy in the treatment of detachment of the retina. Ten years afterwards he admitted that the operation does not cure the detachment although it sometimes improves vision.

In 1872 Galezowski, thinking that detachment of the retina in myopic eyes bears some analogy to glaucoma, thought iridectomy might exercise a favorable influence on the former disease. His subsequent experience of the operation did not justify its routine practice.

Castaldi advised its employment and reported that of five cases of detachment of the retina following iridocyclitis and iridochoroiditis he was able to effect complete reposition of the membrane in three. Westhoff has confirmed this favorable view of the value of iridectomy in retinal separation following uveitis and reports several successful cases.

In this connection one may quote the statistics of Emil Grosz (Nagel's *Jahresbericht*, XXI, 1890, p. 95. Abstracted from the Hungarian.) Of all reported cases to the date of his paper (1890) simple puncture of the sclera failed to bring the least improvement in 44 per cent.; puncture of the retina in 65 per cent., and iridectomy in 66 per cent.

Coppez (*Bullétins et Memoires de la Soc. Franc.*, 1887, p. 85) quotes Dransart as having obtained by this operation eleven complete reattachments in sixteen cases (!).

Puncture of the eyeball with the galvanocautery. Choroido-retinal galvanopuncture. deWecker and Masselon (*Annales d'Oculistique*, Vol. 87, 1882, p. 39) were the first to employ this form of treatment, intended to bring about adhesive inflammation between the choroid and the replaced retina.

The point of the electro-cautery, heated almost to whiteness, is cautiously pressed against that (previously denuded) part of the scleral wall corresponding to the detached area and allowed to burn its way into the sac at the site of punctures previously made with the knife. The cautery point is then immediately withdrawn and the eye treated as after a major operation, with a protective bandage, atropine and rest in bed. If no serious reaction sets in it is repeated as often as necessary.

An instance of complete restoration of the visual field is reported by L. Paton (*Trans. Ophth. Soc. U. K.*, Vol. 28, 1908, p. 150). The sclera was punctured by the electro-cautery, the retina being divided through the opening with a Graefe knife. In this instance the detachment involved the lower-outer quadrants of the retina and the scleral openings were made both above and below the tendon of the external rectus.

Wernicke (*Klin. Monatsbl. f. Augenheilk.*, Feb.-March, 1906, Vol. 44, p. 134) reports upon 422 cases of retinal separation examined in the clinic of Uhthoff, who, by the way, furnishes similar statistics in his paper read at the Congress in Lisbon. Of this number 36 cases were cured or greatly relieved; 8 were cured by operative treatment, 10 by rest and other minor measures, and 18 got well without treatment. Wernicke is much in favor of the galvano-cautery, which, he believes, will best secure extensive adhesions of the retina to the choroid. In the statistics just referred to, in two out of thirteen cases the retina was entirely reattached by the employment of this measure.

Discission of vitreous membranes in connection with retinal detachment. Von Graefe was probably the first to recognize and treat these new formations in the hyaloid body. He understood their interference with vision and their evil action upon the retina. Furthermore, in such cases he did not hesitate to break up the exudates with a discission needle plunged into the eye just in front of the equator.

C. S. Bull has had a large experience in this particular operation. He passes a knife-needle or discission or a heavier needle in front of the equator below the lower border of the rectus externus. The eye must, of course, be free of irritation and the deeper the membrane lies the less dangerous is the operation and the better the results. In 29 such cases Bull had 25 good results.

Bull finds that division of membranous opacities in the vitreous causes but little reaction, and may do positive good (even without division of the detached retina), as it reduces the danger of extension of the detachment. It is positively contradicted in cases where the vitreous opacity is vascularized, as it would certainly induce free hemorrhage into the posterior chamber.

Zimmerman reports a case of detachment of the retina following a magnet operation, in which he was able to break up the vitreous exudate in this way. As a result the detached membrane returned to its proper place with marked improvement in vision. He employed a Graefe knife and passed it through the sclera between the posterior pole of the lens and the opacity. The operation was carried out under observation with the ophthalmoscope.

Abadie has used electrolysis for the dispersion of vitreous opacities. He introduces a platinum-iridium needle 8 mm. long into the depths of the vitreous. The needle is connected with the positive pole of a galvanic battery, the negative electrode being placed on the arm. A stream of three or four milliamperes is applied for five minutes. In a case described by him there was marked improvement in the local condition and in the eyesight.

The single vertical or oblique incision through the sclera. Wolfe's operation. J. R. Wolfe (*The Practitioner,* March, 1883, p. 195) thus describes his operation. He puts the patient under chloroform and introduces the speculum, while the assistant fixes the eyeball with forceps. An obliquely placed slit is made with scissors in the conjunctiva and through the sub-conjunctival tissues, laying bare the sclerotic at a point corresponding to the site of the detachment.

"The lips of the wound are separated by two small [strabismus] hooks, and the assistant steadily maintains the position of the eyeball to prevent the exposed portion of the sclerotic from shifting. The sclerotome is introduced into the sac formed by the fluid. The incision through the sclerotic is made obliquely in such a manner that the edges of the scleral wound should overlap each other and not remain gaping when the instrument is withdrawn. Gentle pressure is made upon the eyeball in the track of the receding lance by means of a fine spatula. The lips of the external wound are brought together with a fine silk ligature or two, and both eyes are strapped with court plaster. The patient is kept in bed in a dark room for three days. The plaster and ligature are removed on the sixth day, and the eye is gradually accustomed to light. On the eighth day the result of the operation may be tested."

The sclerotome referred to is practically a narrow keratome, with rounded angles and a lance-like blade. Wolfe claims that his method differs from a similar operation devised by von Graefe, who directs that "the eyeball be rotated and the puncture made through the conjunctiva, fibrous capsule, and other soft parts, so that the serum is allowed to well out under the conjunctiva to be subsequently absorbed; in his [Wolfe's] operation the fluid is withdrawn at once and entirely. The one is an operation done under cover, in the dark, and may prove a miscarriage; my operation is done in open light, and can be managed with more precision."

Extensive longitudinal incisions of the sclera. Following the example of Wolfe (q. v.), a few operators have advised several long incisions through the sclera, not merely for the purpose of draining the subretinal serous fluid, but to produce lasting adhesions between the previously separated retina and the choroid. These radial incisions are first made through the bulbar conjunctiva and then through Tenon's capsule, extending as far as the folds of transmission.

The globe is fixed with forceps and rotated as far as possible towards the opposite side of the orbit. A Graefe knife, or a small keratome, is passed through the sclera at the border of Tenon's capsule and in a meridional direction as deep as the choroid. It must be borne in mind

in this connection that it is well to avoid the horizontal meridian along which the long posterior ciliary arteries run.

In removing the cutting instrument it may be turned somewhat upon its axis to allow the subretinal fluid to drain slowly away. More than one of these incisions may be made in the eyeball, but sometimes a single cut is enough.

As a rule the cut edges of the conjunctival tissues are brought together with one or two silk or catgut sutures, atropine is instilled, a bandage applied to both eyes, and the patient is put to bed for one or two weeks.

Suturing the separated retina to the choroid and sclera. In 1889 Galezowski (*Recueil d'ophtalmologie*, p. 1, 1890) tried the venturesome experiment of suturing, by means of a stout, full-curved needle and catgut, the detached retina to the sclera and choroid. The needle employed had a rounded contour near its eye, flattened towards its point. It was so fashioned that puncture and counter puncture in the sclera were distant about 15 mm. It is only necessary to mention this operation to foresee the failure that awaits the surgeon bold enough to make it, although it certainly is an improvement on deWecker's gold wire drain, especially as there seems no reason why an adhesive inflammation might not, by the pressure and irritation of the tight catgut thread, bring about a permanent fixture of the errant retina.

Among the accidents in the performance of this operation is the breaking of the needle within the globe. F. Allport witnessed this unfortunate occurrence in the hands of the originator of the procedure, which was followed by panophthalmitis and enucleation of the damaged organ.

In this connection Elschnig (*Augenärtzliche Operationen*, II. p. 701) informs us that Martin uses in the same way two silk sutures, while Evers inserts a horse-hair for the same purpose.

Subconjunctival injections. Although this method of exhibiting medicaments holds only a minor place among surgical operations, so many remedies have in this fashion been employed, and so many surgeons have advised their employment in retinal separation that a brief review of the literature on the subject may be given.

The modus operandi of subconjunctival injections in detached retina is not fully understood. Whether they act (in virtue of the local irritation) by stimulating absorption of the subretinal fluid, at the same time increasing the watery content of the hyaloid cavity, or whether the process of osmosis (exomosis of the subretinal fluid associated with endosmosis of the subconjunctival solution and pouring out of serum from the ciliary vessels into the vitreous chamber)

best accounts for the beneficial results remains to be determined.

It may be mentioned, in passing, that dionin, inasmuch as it acts in a manner similar to saline subconjunctival injections, is indicated as a substitute for these agents in the treatment of displaced retina and, in some hands, appears to be of value.

deWecker (*Traité complet d'Ophtalmologie,* Paris, 1887), probably influenced by Raehlmann's earlier work, was the first to use this remedy extensively. He injected at first without much effect, simple salt solution into Tenon's capsule but, later, added small proportions of gelatine (3 per cent.) to increase the local irritation and consequent diapedesis of the intraocular fluids. He found the effect on the detachment more marked than before and noticed that the disease of the vitreous was distinctly improved.

In 1896 Lodato (*Archivio di Ottalmologia,* Vol. IV, 1896) gave a favorable account of the use of sodium chloride injections in 15 cases of separation of the retina. In 12 of these there was almost total resposition of the membrane; in two only was there complete failure. The successful cases always showed enlarged visual fields and increase in the central acuity.

During the following two or three years there was, in consequence of continued favorable reports, a widespread employment of this remedy, by Gotti, Mazzoli, Dor, Sr. and others.

Dianoux prefers a mixture of 1 per cent. sodium chloride and 4 per cent. cane sugar in distilled water. Of this, 4 or 5 cc. are injected into Tenon's capsule on the first, second and fifth day of the treatment. He has found a series of ten such injections to be effective in detached retina.

Dor, Sr., reported at the Ninth International Ophthalmological Congress the results of treatment of 21 cases. Of these, 14 were cured or much improved, several of them having no relapse after four years. His methods included chiefly injections into Tenon's capsule of 20 or 30 per cent. solutions of salt, the application of the Heurteloupe leech to the temple, thermocautery puncture of the sclera at the site of the detachment, a compression bandage and rest in bed.

Bourgeois (*Recueil d'Ophtalmologie*, 1897, p. 566) used subcapsular injections of the following mixture:—glycerine, 10.0, sodium chloride 3.0 and sublimate solution 0.001—without serious reaction. This medication, in ten cases, led to improvement in seven.

Marple (*New York Eye and Ear Inf. Reports*, 1904, p. 15) has used subconjunctival medication in three cases, but without permanent improvement. He began with 5 per cent. sodium chloride and gradually increased it to 25 per cent., although the stronger solutions were extremely painful.

Guibert (*La Clinique Ophtalmologique,* Sept. 10, 1904, p. 291) tried in three cases the serum-gelatine of deWecker and the serum of Trunecek with one cure, and temporary improvement in the other two.

Bonté (*La Clinique Ophtalmologique,* Jan., 1907, p. 3) prefers subconjunctival injections of 1 cc. of concentrated solution of sodium chloride with three drops of a 1 per cent. solution of acoin, repeated at intervals of a few days; complete rest in bed; cauterization of the sclera at a number of points in the region of the detachment; treatment of the cause, myopia, syphilis, etc.

A. Maitland Ramsay (*Trans. Oph. Soc. U. K.,* 1906, p. 79) has taken all his cases of this condition occuring in hospital practice over a period of four years and reported on the results of treatment by subconjunctival saline injections. The composition of the saline varied in different cases, but the solution ordinarily used was five to twenty minims of 1 in 2,000 bicyanide of mercury with 8 per cent. chemically pure sodium chloride. In some cases acoin and, in others, alypin were used as analgesics. Dionine was occasionally added to the injection. Ramsay lays great stress upon the need of attention in every way to the patient's general health, and especially to the state of the bowels during his period in bed.

The average number of injections was five, and the average duration of treatment one month, but prolongation of the period in bed is probably beneficial if the case is one which is improving. On the other hand, if, after fourteen to twenty-one days, there are no signs of improvement, the case may be considered incurable. There were fifty patients treated by this authority, of whom twenty-seven received no benefit whatever. Of the remaining twenty-three, ten showed very decided improvement. Of these ten, five afterward relapsed, the shortest period being two weeks and the longest four years after conclusion of treatment; of the remaining five, three were satisfactory after one year and two were lost sight of. The other thirteen of the benefited cases showed moderate improvement; some of them relapsed. Ramsay concludes that the favorable cases are few, the unfavorable many; but however hopeless the latter may at first seem, it is always well, before coming to the conclusion that nothing can be done, to try the effect of such simple treatment. It can at least do no harm.

Ramsay gives the following as the formulæ of the various fluids used by him in the subconjunctival treatment of amotio retinæ.

I.

Sodii chloridi (chemically pure), 8 per cent.
Sol. hydrarg. bicyanid., 1 in 2000, 92 per cent.
Misce.

II.

Dionine, 1 per cent.
Sodii chloridi (chem. pure) 8 per cent.
Sol. hydrarg. bicyanid., 1 in 2000, 91 per cent.
Misce.

III.

(Dor's fluid)

Sodii chlorid	grammes	5.
" carb.	"	0.40
" sulphatis	"	0.40
" phos.	"	0.10
Potass. sulphatis	"	0.40
Aq. destillat. ....ad	"	20.

Misce.

Staerkle publishes the outcome of subconjunctival injections in 23 instances, with three cures. His conclusions touching this form of treatment are as follows:—

1. The subconjunctival injection of common salt solution forms a harmless and almost painless means of stimulating the absorption of pathologic exudates within the eye.

2. Up to a certain point the stronger the solution the greater the effect. The writer employed three strengths only, 2 per cent., 4 per cent. and 10 per cent., and found these in every way adequate.

3. On the whole, the improvement in the anatomical conditions, as well as in the visual fields and central vision, was more marked as time passed and the injections were continued.

4. The injections had a greater influence on recent, partial detachments than on long-standing and widespread examples of separation of the retina. Intermediate forms were variously affected by the treatment.

Intraocular injections of iodine. Fano (*Traité des pratiques des Maladies des Yeux*, 1866, p. 417) was probably the first to propose that an irritant fluid be injected into the sac, combined with simple scleral puncture, "to set up an adhesive inflammation between retina and choroid." Galezowski also has a reference in the first volume (1872) of the *Journal d'Ophtalmologie* to a case in which "iodine injections has been tried without success." It was not, however, until sixteen years later that a definite operation, based on exact pathological findings and animal experimentation, was presented to the profession.

In 1890 Schöler (*Berlin. Klin. Wochenschr.*, 34 and 35, 1890, p. 768-798; see, also, his monograph on the whole subject, *Zur Operativen Behandlung und Heilung der Netzhautablösung*, Berlin, 1889) reported 26 cases of detached retina in which he had made injections into the posterior chamber of a few drops (2 to 6) of iodine preparations. Permanent reposition of the separated membrane followed in six cases and in two decided relief had been given. In three cases, however, destructive hemorrhage set in, while five others were much worse after than before the injections. In the others temporary improvement was noted. Two patients were treated with sodic salicylate injections; one with Lugol's solution.

The choice of iodine preparations followed the author's experiments on animals, which he was led to make because of Leber's and Nordensen's researches in the pathology of the disease. He conceived the idea that, since many cases of separated retina result from the formation in a degenerated and shrinking vitreous of fibrils whose tension upon the membrane draws it away from its choroidal bed, this process might be favorably influenced by intravitreous medication. He employed mercuric iodide, sublimate, sodic salicylate and iodine solutions, finally choosing the last as best applicable to human eyes.

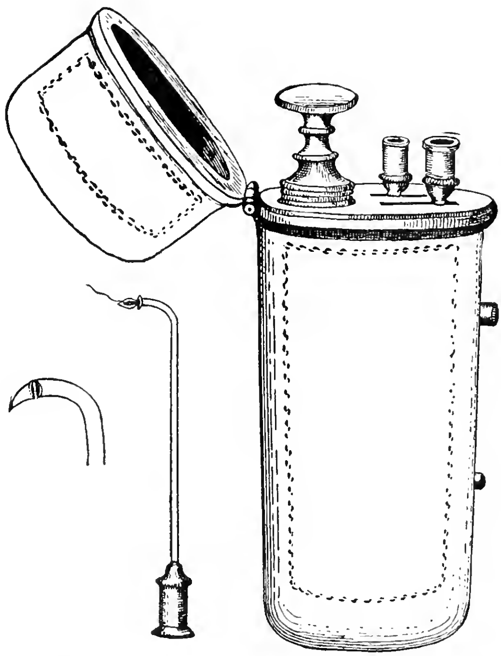
In the Schöler instrument the mouth of an ordinary Pravaz syringe is fitted with, instead of the usual needle, a small, hollow, gold-plated, platinum tube whose terminal is a narrow knife, pointed and curved like a strabismus hook, the whole being about 4 cm. long and 2 mm. in diameter at the middle. The knife itself is 2.5 mm. long and 1.25 mm. wide. At the junction of the small knife with the canula there are two openings about 0.4 mm. in diameter. These indicate two little gutters along the side of the knife that carry the fluid from the syringe into the eye. The cutting end is passed through the scleral wall and the injection follows without the necessity for withdrawing the needle. In small detachments one injection of, say, two drops of the iodine solution, was made in one locality; if extensive, another dose was administered at the antipodes of the first.

In addition to this canula-knife Schöler employed a second terminal in which the canal from the syringe ended on the back of the knife.

He operated on some patients sitting; on others in the prone position. Before entering the canula knife the conjunctival and subconjunctival tissues were, after careful disinfection and cocainization, divided with fine scissors so as to allow of easy penetration of the underlying sclera. In the majority of cases from 2 to 4 drops of the tincture of iodine (in two instances 6 drops) were slowly injected.

Generally increase of tension and dilation of the pupil followed. The point of the instrument was slowly withdrawn and the wound of entrance was not sutured. The eye was then examined with the ophthalmoscope, atropin or hyosein instilled and a bandage applied for 6 to 8 days.

The pain that followed these injections was most severe just after the operation, but it rarely lasted more than half an hour, then decreased and finally disappeared. In one case only was a hypodermic of morphia needed.



Schöler's Instruments for Intraocular Injection.

In the literature of this subject will be found descriptions of several modifications of the Schöler instrument for intra-vitreous injection in the treatment of detached retina.

Abadie's syringe, for example, is fully described in the *Archives d' Ophtalmologie,* 1889, page 461.

The rather complicated injection apparatus used by Pflüger, to the form of which he attached considerable importance, is described and pictured as follows by his pupil, Eissen.

The inventor points out the defects of the Schöler instrument—the difficulty of introduction, the considerable force required to pass the

large hook-shaped knife of canula through the sclera (especially if the tension be minus), the uncertainty in estimating the number of drops of the medicament injected and the frequent escape of fluid vitreous and of the solution through the opening after the withdrawal. He believes that these drawbacks greatly diminish the successful chances of the operation and has endeavored to minimize them in his own instrument. This is in the form of a metal Pravaz syringe capable of being sterilized without injury at 200° C. The plunger, graduated to 1/100 c.c., is controlled by a cogged wheel so arranged that by means of the thumb and forefinger, it can be shoved forwards (only) with the greatest accuracy. As represented in the cut, the fine, easily penetrating needle is provided with a small stop-cock, to be turned after the injection and while still in situ, to prevent oozing of the intraocular contents.

At the time of the foregoing report the syringe had been used in 12 cases of detached retina without accident, marked pain or untoward result.

Galezowski followed Schöler by directing the injection into the subretinal space—with or without the use of his catgut suture.

Abadie made a simple scleral puncture and after allowing some of the fluid to escape injected a few drops of iodine dissolved in a solution of potassic iodide. He had one good result in 10 cases. Dubarry also reports six cases from Abadie's clinic; one was a complete cure; two improved for a short time; two got or were made worse.

Stedman Bull (*Medical Record,* Jan. 16, 1892, p. 62) gives the history of five cases treated by him without a single successful issue, and the loss of sight in one eye from panophthalmitis.

Schoenfield sums up the results in 75 cases treated by various surgeons. Of these only three are reported to be complete and permanent cures.

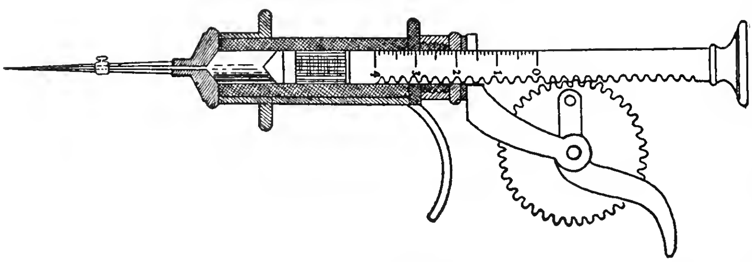
Perhaps the report that influenced the profession most strongly against this procedure was that of Gelpke's case (*Centralbl. f. pkt. Augenheilk.,* Sept., 1889, p. 260)—infective purulent uveitis, meningitis and death following a careful injection of three drops of iodine tincture.

Iodine injections into the subretinal sac. This procedure, as stated, has been recommended by several surgeons, but especially by Fano, Galezowski and Dufour. In cases of retinal separation due to postretinal fluids, semi-solid exudates, hemorrhage or traumatism this treatment seems not irrational, but in those forms of the disease associated with shrinking of the vitreous or cyclitis, subretinal injections alone can hardly be justified. In any event very few successful cases have been reported as the outcome of this method.

Electrolysis of the postretinal fluid. Terson (*Bulletins et Mem. de la Soc., Franç. d'Ophtal.*, 1895, p. 151) employed this method in at least 12 cases and held it superior to any other operative method, especially less dangerous than that of Abadie or Schöler.

The electrolytic needle, made of platinum or platino-iridium, is thrust into the retinal sac through a small opening previously made by scissors and knife through the ocular tunics. It is then connected with the positive pole of a galvanic battery and under a 5 milliampere current the electrolysis is carried on for about one minute.

W. T. Montgomery (*Medicine*, June, 1896, p. 483) gives an account of four cases treated by the Terson method. Positive electrolysis was used. The eye was punctured by a strong platino-iridium needle at the point in the sclera corresponding to the subretinal sac and a current of 5 ma. applied for a minute. The eye was always well cocain-



Pflüger-Eissen Syringe for Intravitreous Medication in Separation of the Retina.

ized and patients did not complain when the eye was punctured, but as soon as the current was turned on they experienced decided pain. The after-treatment was the use of a 1 per cent. atropine solution, a compression bandage and rest in bed for a week. There was no noticeable reaction in any of the cases. The electrolysis was repeated as often as was considered advisable. In none of the cases was there any improvement whatever, while one of the patients developed glaucoma, which the author thinks was a direct result of the treatment.

Induction of labor in the treatment of ablatio retinæ due to the albuminuria of pregnancy. This subject is well presented by Allen Greenwood and Edward Williams. They collected and gave a synopsis of the literature in 11 cases which with their own (2) made a total of 13 instances. The majority of the writers quoted advise the induction of abortion or premature labor as the most important element in the conduct of these cases.

Multiple retino-choroidal puncture. Among the numerous operative procedures for the relief of detached retina advocated by that inven-

tive surgeon, Galezowski, is multiple puncture of the choroid and the separated membrane.

The instrument he employed for the purpose had the shape of an arc of a circle—a stout curved needle—not unlike that he used for the introduction of his catgut suture. A number of punctures and counter-punctures were made in the eyeball, the needle at each insertion passing through the detached retina. In this way he hoped to push or pull the membrane towards the choroid, making a number of retino-choroidal cicatricial points sufficient to keep the replaced retina in its normal position. He reported 17 cases treated in this way, five with partial and two with signal success.

Pagenstecher, according to Scheffels, also used a common steel needle for multiple puncture of the sclera, choroid and detached retina, an operation that was followed by good results.

Elschnig says that Pagenstecher used also a Knapp's knife to make multiple puncture of the sclera, choroid and retina, and that Galezowski tried multipuncture of the sclera and retina in the area of the detachment with a pointed knife which he called his ophthalmotome.

August Brück describes in detail the method of H. Pagenstecher. The post-retinal fluid is drawn away by means of a simple puncture. Afterwards, with a discission needle, four additional sclerotomies are made in the region of the detachment, rather close to one another and through the sclera, choroid and retina. The post-operative treatment consists in the application of a pressure bandage and complete rest. The essayist gives the results of treatment in several cases and concludes that where multiple puncture with the knife or knife-needle does not bring about a complete cure, it at least prevents a spread of the separation.

Wernicke has shown by experiments on normal rabbits' eyes that scleral punctures do produce adhesions between the retina, choroid and sclera. The question is whether these results are equally effective in detachment of the human retina.

Punctiform cauterization of the sclera and episcleral tissues. H. Dor (*Ophthalm. Klinik*, 1907, p. 618. See, also, loco cit., a number of earlier observations on the subject by this surgeon) has long been in favor of punctiform cauterization of the sclera in the neighborhood of the detachment. In common with others, he believes that the marked irritation set up in the sclerotic tissues brings about an inflammatory adhesion between the replaced retina and the opposed choroid.

Elschnig, in the second edition of Czermak's "*Augenärztliche*

Operationen," gives a complete account of this operation, a part of which is here translated.

The sclerotic is exposed by a meridional incision through the conjunctival tissues overlying the scleral coat which, after bleeding has stopped, is punctured at half a dozen or more points with the red-hot galvano-cautery.

This minor operation is done under cocain-adrenalin or, in the case of very sensitive patients, subconjunctival cocain injections may be employed. The conjunctival folds of transmission between two of the straight muscles are taken up with a fixation forceps and slit right to the corneal margin with scissors. The underlying fibres of Tenon's capsule are also cut through, thus making a wound 8 to 12 mm. long.

The edges of the wound are then separated by means of hooks, the eye-ball rotated with a fixation forceps in the opposite direction, so that the sclera in the neighborhood of the equator is freely exposed. It is best to hold the wound edges apart with two small [strabismus] hooks—[Stevens' act very well.] It is in the sclera thus exposed that the burned points—five or six are generally sufficient—of the cautery are placed. Care must be taken not to perforate the scleral wall.

Sattler, having placed the cold cautery point in the wound, afterwards turns on the current until the cauterization is completed.

If, on removing the cautery-point from the wound, it is found adherent to the tissues, the current should be again applied, when it is more easily removed from the charred tissues.

The edges of the conjunctival incision are now brought together with silk or catgut, the wound is dressed and a bandage applied. The sutures may be removed after two days.

The cauterization may be repeated as soon as the eye is once more free of irritation. If, however, the application is too frequently made, there is some danger of one of the straight muscles becoming attached, by scar tissue, to Tenon's capsule.

There can be no doubt, as Wernicke and others have shown, that this method does induce marked inflammatory adhesions of the retina to the choroid.

II. Dor does not like the electro-puncture, but prefers the actual cautery in the form of Guersant's needle, because that instrument is provided with a "stop" which prevents too deep perforation of the sclera. It is heated red-hot in an alcohol flame and applied to the conjunctiva. The objection to this method is that it brings about a marked contraction of the ocular conjunctiva, as well as cicatricial adhesions of the overlying tissues to the sclerotic.

Wessely has exposed the sclera of a patient suffering from exudative detachment of the retina to small jets of hot steam directed against the sclera by means of a metallic cylinder. At the point of cauterization a chorioretinitic exudate could be seen.

Elschnig considers the principal value of all these local cauterizations to lie in the fact that the sclera is contracted by the formation of scar tissue in it through these burns, so that the size of the eyeball itself is reduced. In other words, galvanic and other forms of cautery bring about the same result that one gets in Mueller's (q. v.) operation. He has employed the cautery in connection with scleral puncture and believes that, in this way, he obtains better results than ordinarily flow from either method alone.

One finds in the literature of this subject many combinations of other methods with galvano-puncture. For example, Deutschmann (*Beiträge zur Augenheilk.*, Part 67, 1907, p. 379) combined multiform puncture (in ten eyes affected by separation of the retina) with his own operation of bisection (q. v.), but he did not find that the cautery punctures contributed much to the favorable result.

Uhthoff employed cauterization in conjunction with scleral puncture, after which two of the cases so treated were cured. Compared with this result in nine cases treated by puncture, one was healed.

H. Dor (*Bulletins de la Soc. Franç. d'oph.*, 1907, p. 342; consult, also, *ibid.*, Vol. 13, 1895, p. 181-183) reports over 40 cases of retinal detachment in which he made use of a combined treatment, employing the artificial leech, punctiform cauterization and the injection into Tenon's capsule of 10 per cent. sodium chloride solution. Seven of the patients were decidedly improved, five satisfactorily improved and in three there was small improvement. In ten cases there was complete failure.

Deutschmann's operations. Bisection, with and without the intra-vitreous injection of sterile animal vitreous. In 1895 R. Deutschmann, (*Beiträge zur Augenhlk.*, part 20) of Hamburg, first published his classic description of two operations for which he still claims results unattained by any other form of treatment. He is opposed to waiting until non-operative measures have been tried, but advises us to proceed at once to the more effective employment of surgical intervention. The simpler bisection ("Durchschneidung") method he regards as especially valuable in the more acute or recent cases; the combined procedure he reserves for the advanced and less hopeful forms of the disease.

Deutschmann claims that "bisection" reduces the tension on the shrunken retina, which in his experience may be so marked that it is

impossible to reattach it without making one or more incisions in the region of the ora serrata. He not only evacuates the subretinal and preretinal fluids but tries to produce small inflammatory or exudative adhesions between choroid and retina. With the injection of animal vitreous into the posterior chamber he produces a mechanical pressure on the detached retina against the choroid, and a welding of both membranes on an inflammatory basis, with simultaneous re-filling of the eyeball. Relapses may occur with either or both methods, but under these circumstances he repeats the operations in an attempt to regain what has been lost.

The author refers to the favorable statistics of Horstmann (6.66 per cent. of cures), and Uhthoff (16.10 per cent.), as the result of operative interference, but believes that much better success can be attained by his methods. As evidence he gives his own experience. To July 1, 1909, he had operated on 302 cases of retinal detachment, the treatment being concluded in 267 instances. Of these he cured 70, or 26.1 per cent., improved 94 or 35.2 per cent., failed in 103 or 38.7 per cent. From these totals, however, he subtracts a number of cases on whom the operation was performed as an experiment, without the least chance of recovery of sight (the patients fully understanding the situation) with these results: cured 31.1 per cent.; improved 41.3; not cured 27.6 per cent.

Bisection of the vitreous and retina. This operation is never employed in cases where the detachment is above the equator; when one has to deal with such it is better to wait, without treating the patient, until the subretinal fluid has gravitated downwards.

After thorough disinfection and cocainization a two-edged, linear knife about the width of a medium-sized Graefe, is entered at a tangent to the globe(through conjunctiva and sclera well back of the ciliary region), passed quickly forward and then downward and backward, sweeping towards a counter-puncture at the other extremity of the ocular diameter, so as to "cut in two" as much as possible of the vitreous chamber without wounding any surgically important structure. The point of the knife should penetrate the sclera and lift up the overlying conjunctiva but should not pierce the latter. Draw the knife out as quickly as it was entered, turning it a little on its axis so as to allow the subretinal as well as some of the preretinal fluid to escape. See the illustration.

This manœuvre may be repeated as often as twenty times or more, with sufficiently long intervals between successive operations to permit the eye to recover from the reaction, which, however, is generally small or nil. Of course this interval must be a longer one if one of the

larger retinal vessels has been wounded, or any unforeseen accident should occur. A celluloid shield should then be applied to both eyes or if a bandage be used, it should be a loose one for the first 24 hours. After the first day cover only the eye operated on, which must be kept under the influence of atropine during the whole period. Keep the patient in bed for 7 or 8 days after each operation and watch results with the ophthalmoscope.

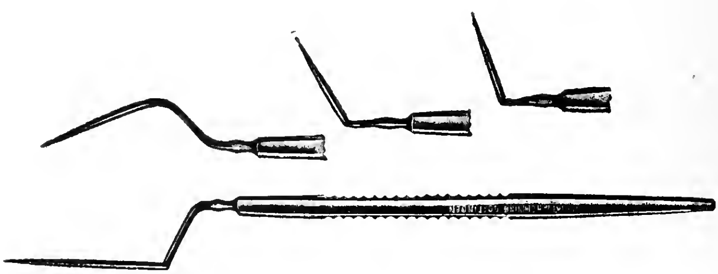
Deutschmann's Bisection Operation.

As a rule, when these directions are strictly followed under careful asepsis, the operation is without danger to the eye.

Combined bisection and intravitreous injection of animal vitreous. Deutschmann reserves this operation for those cases in which vision has sunk very low or where other means of restoring sight have failed. He says that while one must not expect too much from it, yet by its use he has been able to save a small percentage of eyes in desperate cases. He also claims that, carried out under full cocainization and with strict aseptic precautions, it does not endanger either the eye

operated on or the fellow eye. The pupil should be fully under the influence of atropine.

The instrument employed by Deutschmann (glass syringe) allows only an advance forward of its piston. This arrangement is provided so that no deleterious suction can be practised upon the contents of the eye should the finger by chance be removed from the piston end. As nozzle for the syringe one may employ either a platinum-iridium canula, or a double-edged knife canula. Deutschmann much prefers the ready-to-use, sterilized vitreous body of absolutely fresh calf's eyes, hermetically sealed in glass tubes. There are two kinds of calf's vitreous: No. 1, made by the filtration of freshly-boiled vitreous body, afterwards re-sterlized by boiling in hermetically-sealed glass tubes. This preparation has a weaker action than No. 2, which is composed of fresh vitreous body inspissated at 40 degrees Cent. in vacuo, and the



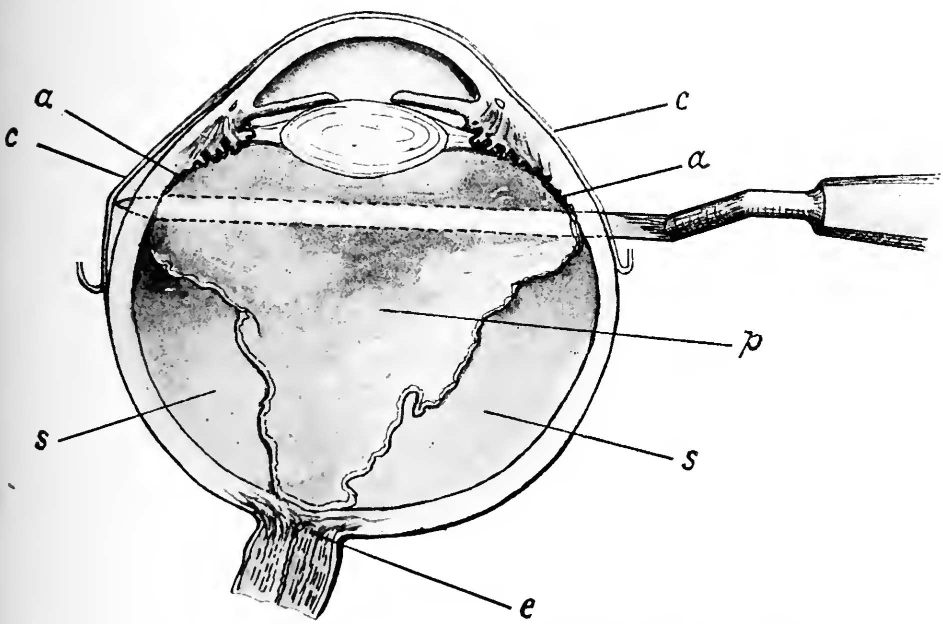
Deutschmann's Knives for the Bisection Operation in Detached Retina.

residuum taken up with physiological salt solution—sterlized by boiling—so that the component parts of normal but concentrated vitreous body are contained in it.

The technique of this intravitreous operation as given by the author is as follows: "To bring the retina once more as close as possible to the choroid by means of the pressure of the injected animal vitreous it is, of course, necessary to get rid of the subretinal fluid. If one uses the point of the ordinary platinum-iridium canula then the procedure is as follows: The syringe, filled with the animal vitreous, is best introduced in the region of the ora serrata, somewhat outwards and downwards. It is given to the assistant to hold while the operator, with the double-edged linear-knife, makes the usual simple bisection downwards. After the completion of this manœuvre, he, with the syringe, injects into the eye very slowly some of the contents of the barrel. It is generally sufficient to push forward the piston 1.50 to 2 divisions, according to the consistency of the eye. Then, the syringe point is withdrawn and the puncture closed with toothed forceps for

some minutes, that none of the fluid injected may escape from the eye. To use the syringe with the canula-knife, omit the usual bisection and insert knife point of the syringe, filled with animal vitreous, in exactly the same way as is directed in the bisection operation with the double-edged knife. One may introduce the canula-knife up to the point of the counter-puncture but in all cases avoid moving the point from side to side. See the figures.

On the introduction of the syringe the subretinal fluid flows out. Then one immediately presses the syringe piston forward, thus making



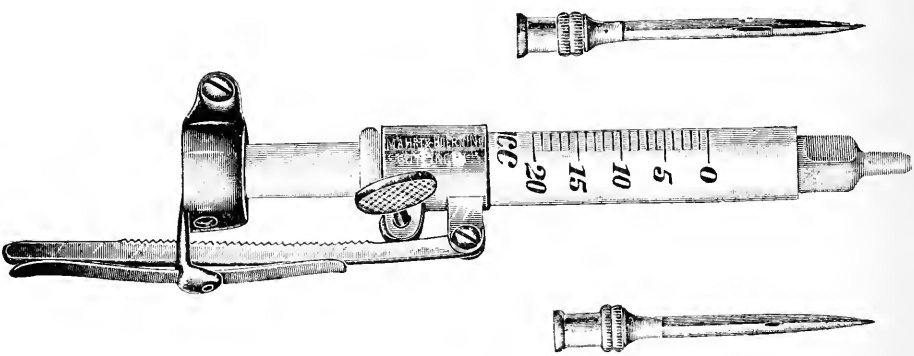
Deutschmann's Bisection Operation for Detached Retina. The direction of the knife in typical cases. *a*, Ora serrata. *p*, Preretinal space with preretinal fluid. *s*, Subretinal space with subretinal fluid. *c*, Conjunctiva. *e*, Optic nerve-head.

the injection. The point of entrance is in this case also held together with forceps after the removal of the syringe.

After the operation both eyes are lightly bandaged for 24 hours, then one eye only. Further measures depend upon the reaction shown by the eye. This reaction, again, is dependent upon the concentration of the animal vitreous used. "I must here state that to spare my colleagues every unpleasant experience, they must begin with the weaker preparation, and, since the operation can with perfect safety be repeated several times, gradually go on to stronger ones.

These injections demonstrate that the reaction of the eye becomes reduced with each use of the remedy.''

For the first injection one should dilute vitreous preparation No. 1 with equal parts of sterilized physiological salt solution; for the second use the solution pure, and so on. Inflammatory symptoms, such as may appear at various periods up to the eighth day after the operation are, as a rule, easily controlled by atropine and hot applications. ''If increase of tension set in, one should at first wait quietly; only when the pain becomes very severe, and perception of light is somewhat worse under the influence of the heightened tension should one interfere and do another simpler bisection.'' It should always be borne in mind that after every injection the vitreous body will become more or less cloudy. This translucency gradually clears up completely. Even if it assumes a yellowish, abscess-like appearance



Deutschmann's Syringe (canula-knife) for Intravitreous Injections.

it becomes clear and normally transparent again in the course of a few months. It is only now and then necessary to assist absorption by hot applications or by an occasional salt injection.

Deutschmann believes that a hemorrhage occurring between the choroid and retina assists rather than hinders the subsequent inflammatory adhesions between the two tunics.

Mueller's operation. Resection of a portion of the scleral wall. The originator of this operation, Leopold Mueller, (*Klin. Monatsbl. f. Augenheilk.*, May-June, 1903, p. 459) was led to perform it because of his belief that many cases of detachment are due to the disproportion between the shrunken or shrinking vitreous humor and the ocular envelopes. He proposes a rather formidable but, he claims, successful remedy for this condiiton, no less than an attempt to reduce the size of the eyeball.

Since it is impossible to attain asepsis of the conjunctiva, Müller operates on the globe behind the equator.

Krönlein's resection of the temporal orbital wall (q. v.) forms the first stage of this new operation. The technique is as follows:—the Krönlein resection done, the temporal aspect of the eyeball is thoroughly exposed. The external rectus is then divided, the cut ends being secured by fine sutures, so that they may be later reunited.

The operator now carefully and slowly excises with a sharp scalpel a bi-convex piece of sclera 20 mm. long (with its length parallel to the equator), and 8 to 10 mm. wide, in such a manner that its anterior edge lies 1 or 2 mm. behind the insertion of the external rectus. Its posterior margin should correspond to the equator. The edges of the scleral wound are now brought together by five small stitches.

In the performance of this operation care must be taken not to injure the choroid, but, just before tying the scleral sutures, the subretinal sac is tapped with a narrow knife and some of the fluid allowed to escape. The cut ends of the externus are now carefully approximated and the bony plate, skin, etc., readjusted. When the wound is closed the whole eyeball is smaller than before.

Mueller reports three cases in which he had done this operation, after which the separated membrane resumed and held its proper position for 10, 11 and 15 months respectively.

Lang's operation. Maser's operation. The object of this surgical measure is to make an irregular or ragged wound in the retina, as well as to evacuate the subretinal fluid.

A Graefe knife is passed through the ocular wall into the retinal sac. It is then turned at right angles, a retinal discission made and the knife withdrawn. In this way it is hoped that the ragged wound in the sclera-choroid and the retina may heal together. G. W. Maser (*Jour. Kas. Med. Society*, July, 1905, p. 279) reports the treatment of a case by this method. Reattachment took place and continued to be complete three months after the operation.

The technique is given by Maser as follows:—a triangular flap is made in the conjunctiva over the sac-area, preferably between the attachments of two straight muscles. After the hemorrhage has ceased a thin Graefe knife is pushed through the sclera, choroid and retina well into the posterior chamber. The knife is now turned at right angles to the wound of entrance and the serous fluid is allowed to escape. The retina is then further incised at right angles to the first incision. Considerable reaction follows this method. After the operation he bandages both eyes, puts the patient to bed and keeps him in the recumbent position for a week or more. A series of these pos-

terior sclerotomies with extensive incisions of the retina are made at proper intervals until complete reposition of the retina is established.

The difference between this operation and that of von Graefe is that Lang does his dislaceration after puncturing the sac, while Graefe approached the detached retina in front of the sac. In other words, the operator does with a thin knife what Bowman attempted with two needles—to bring about a jagged wound and to set up a decided adhesive inflammation in the retina thereby.

Other surgical procedures. The long list of operations and remedies described or mentioned in the preceding pages might be extended if it were at all profitable to give space to such measures as appear to have little or no claim upon our attention. For example, we have refrained from speaking of setons, blisters and leeches because these adjuncts to operative treatment belong to a past era in surgery. Discission of the transparent lens does not seem a rational proceeding and, for that matter, has few serious advocates. For information regarding such refinement of surgery as sclero-dictyotomy (see the *Thése de Paris* of Debierre, No. 264, 1881, p. 633), injections of air into the hyaloid cavity, operations on the neighboring cavities (vide Fish, *Ophthalmic Record,* June, 1904), the application of galvanism, of the faradic current, etc., the reader is referred to the rather sparse literature on these subjects.

In addition to the observation and opinions set forth above the Editor presents in chronological order the views of a number of other ophthalmic surgeons.

Wernicke (*Prac. Med. Series.* Eye, p. 109, 1907) believes that no operative treatment gives assurance of certain recovery from detachment of the retina, and the cures numerously published admit of no certain conclusions as to the value of any method of operation. Wernicke quotes the literature of permanently cured cases up to 1905, which had been observed for at least a year. The total number of cured cases is 351, of which 84=24 per cent. were operated on, 158=45 per cent. treated, 109=31 per cent. not treated.

At Uhthoff's clinic (1906) twenty-two cases of detachment of the retina were permanently cured from March 1, 1896, to March 1, 1903. In the last two years fourteen further patients were seen, of whom the histories are briefly given. These recoveries occurred in 422 cases of detachment of the retina (8.5 per cent.): Eight were treated with operation, 10 without operation, 18 not at all. The causes were in 25 myopia, in 3 traumatism, in 8 unknown. On 65 cases out of 422, the following operations were performed: 1. Repeated punctures with von Graefe's knife in 9 cases=15 per cent. One case was cured.

In the other four the readjustment lasted only for a few days or weeks. 2. Puncture with von Graefe's knife or Knapp's discission knife with following subconjunctival injections of 2 to 5 per cent. NaCl in 41 cases=62 per cent., of which 2 remained cured, 11 showed reattachment for some days or weeks. 3. Galvano-cauterization with divers punctures in 13 cases=20 per cent., of which 2 were permanently cured, 7 transiently. 4. Discissions of the vitreous, according to Deutschmann, in two cases yielded no favorable results. Not more than 15 cases=7.8 per cent., were permanently cured by operation. Only one case was damaged, so that even in consideration of this small number of results operation seems to be indicated.

Replacement of a bilateral detachment of the retina following treatment of the nose is reported by Widmark (*Ophthalmic Review,* p. 281, Sept., 1908). The Editor believes this to be a so-called "spontaneous" cure, and that the result had little or nothing to do with the nasal treatment.

The patient was a lady, 62 years of age, who, when seen for the first time, gave a history of fever, marked swelling of her eyelids, protrusion of her eyes, and considerable diminution in her sight some six weeks previously; this attack had passed off after a few days, but was followed by several attacks with similar symptoms and subsequent improvement.

On examination it was noted that both eyes exhibited slight exophthalmos, while the movement of the external ocular muscles was unimpaired; the lower part of the conjunctiva bulbi on both sides was slightly injected and moderately chemosed; the pupils were small but reacted to light; vision varied from ·6 to ·3; H. 1·5 D. Ophthalmoscopically there was seen detachment of the retina below, and over the fundus (particularly over the lower half) were scattered numerous small pigment-spots that seemed to lie in the retina; there was no sign of a rent in the retina; the fields of vision showed at their upper periphery a moderate degree of contraction.

These symptoms, combined with such a history, pointed to some inflammation in the orbit, and the fact that both orbits were similarly affected suggested some disease of the nose and its accessory sinuses. A week afterwards the patient had another attack, when the left eye began to show very marked swelling of the lids and exophthalmos and an increase in the size of the retinal detachment. The signs pointed to a commencing orbital abscess and led the author to make an incision into the orbit; but the result was negative. The suspicion of orbital abscess was subsequently confirmed by the statement of a colleague who informed Widmark that two years before he had treated the

patient for retro-nasal catarrh, polypoid degeneration of the mucous membrane over the middle turbinal and ethmoidal bones, and empyema of the maxillary sinuses; and thought it not unlikely that the lamina papyracea had been injured at the time of the removal of the polypi.

The patient was now put under appropriate treatment for the disease in her nose, with the result that the condition in the orbits very quickly improved and the detachment of the retina grew less. In twelve days the detachment in the right eye had disappeared and the vision rose to ·9, while that in the left had also become completely replaced within a month.

A slight recurrence of the symptoms appeared subsequently, but without any sign of detachment of the retina. The patient was seen again after four months, when it was found that the fields were normal, the retinæ were in perfect position, but the numerous pigment-spots over the fundus were still present.

Widmark comments on the rarity of orbital inflammation as a cause of retinal detachment and quotes two cases previously recorded by v. Graefe and Berlin. In all three the detachment of the retina quickly disappeared after evacuation of the orbital abscess. From these results he infers that the prognosis of detachment from this cause is very good as compared with that of the more common form; it is probable indeed that the fluid beneath the retina is a serous exudation similar in character to the edema which accompanies abscess formation elsewhere. Leber had put forward the suggestion that in those cases of so-called retinal detachment which cleared up quickly after the evacuation of an abscess there was no real detachment, but that this condition was only simulated by the in-pushing of the coats of the eye, as is known to occur with orbital tumors. Such an idea, however, Widmark rejects as being out of the question in this case.

It is claimed by Bonté (*La Clinique Ophtal.*, Jan. 10, 1907) that the simplest surgical treatment of detached retina should include evacuation of the fluid interposed between the retina and choroid and bringing about an adherence of the disassociated membranes. The most simple measure is scleral puncture or posterior ophthalmotomy for the evacuation of the subretinal fluid.

Graefe with a cataract needle and Bowman with two needles entered the vitreous; this was not a success. deWecker and Masselon endeavored to establish drainage with a fine thread or a small gold canula. The electrolysis of Schoeler is really a drainage. The first indication is best met by the galvanopuncture of deWecker, who made repeated applications upon the sclera, establishing plaques of

adhesive choroiditis. Bonté combines subconjunctival injections with the galvanocautery applications as follows; subconjunctival injections of a cubic centimeter of a concentrated solution of chlorid of sodium with three drops of a 1 per cent. acoin solution repeated at intervals of a few days; this is continued as long as vision is definitely augmented. He also advises horizontal decubitus during the treatment, application of the galvanocautery point to the sclera over all the region corresponding to the retinal detachment, treatment of the cause, such as the correction of myopia, treatment for syphilis or rheumatism, etc.

Deutschmann (*Beiträge zur Augenheilk*, p. 379, 1907) still claims that he obtains better results from his methods of operating than are available by others with other methods.

Deutschmann asserts that it is unfortunate so many oculists consider even the least operative interference in detachment of the retina a daring undertaking, because this view retards the progress which can be achieved only by the combined work of many.

Deutschmann concludes that no other kind of surgical treatment of detachment of the retina is as effectual and harmless as his discissions, and that, if these fail, a moderate percentage of these eyes may be saved from blindness by his intrabulbar injections of vitreous.

Dor (*Prac. Med. Series*, Eye, p. 91, 1908) makes use of local bleeding, electrolysis, punctures, etc., but the basis of treatment in all of the twenty-five cases described was saline injections of various strengths into the capsule of Tenon. In twelve of these cases he obtained a complete reapplication of the retina and full vision, in four a decided improvement, and in nine no result. Five of the twelve cases relapsed in about a month, five had partial relapse but remained unimproved, and there remained but two that were permanently cured. His final statistics were, two complete cures, nine partial cures, and fourteen failures. He concludes that treatment should not be one of two or three but of five or six months. Prolonged treatment is necessary, and patients should not be allowed to resume their occupation for five or six months or a year. The reattachment is the commencement of cure, but not in itself a complete cure.

Spontaneous cures (or reattachment of the dislocated membrane without active treatment) are not very rare. The Editor has seen two examples in one year. Here is another, recorded by Hirschberg (*Centralbc. f. Pkt. Augenheilk.*, March, 1907). A woman, aged 50, who, from her 16th year, remembered to have been myopic, but never wore glasses, accidentally threw her shoe against her right eye. She

noticed a fine, dotted, movable veil before this eye, and three weeks later, a fixed dark area. V=perception of the light of a candle at 2 cm.; projection uncertain and was lacking below. T. very much diminished. Detachment of upper portion of retina, which showed a rupture near the lower border. Treatment was limited to rest, slight diaphoresis, iodid of potash; a bandage was not tolerated. After three days the soft, painful form of detachment, described by Hirschberg, was fully established. T.— 3, very deep anterior chamber, great sensitiveness to pressure, a synechia downward, vitreous very hazy. A month later improvement was noticeable; anterior chamber was not as deep, tension almost normal, V.= fingers at 2 m., but the retina was detached all over, with two ruptures in its upper prominence. After two further months the retina was reattached, opacities of vitreous and blood were seen at the lower portion, and four weeks later recovery was complete. No trace of the ruptures could be seen, only slight opacities of the vitreous and pigment changes remained.

Sachs (*Wien. Klin. Wochenschr.*, Oct. 17, 1907) reports a case in which one eye had been already lost by detachment of the retina, and for the same condition arising three weeks previously in the second eye the usual treatment of rest, bandage, and subconjunctival injections of salt had been employed without effect. Sachs tried scleral puncture, followed by cauterization, on five occasions, but this resulted only in temporary disappearance of the separation for a few days after each operation.

It then occurred to him that to be really efficacious the puncture should be made in the position where detachment usually starts and where it becomes most marked, viz., a little behind the equator of the globe, half way between the ora serrata and the optic nerve, the two situations of definite fixation of the retina; adhesions of the retina to the choroid and sclera obtained so far back would act as a dam and prevent the passage of subretinal fluid forwards.

The operation is performed as follows: The conjunctiva is raised and after fixing a loop suture in the superior rectus or other muscle, as the case demands, it is cut across, the eye is rotated away from the cut muscle and the blade of a sickle-shaped knife passed backwards on the flat over the greatest convexity of the globe. The point is then pressed against the sclera in such a way that it divides that structure equatorially, i. e., in a frontal plane. The subretinal fluid escapes, the cut muscle is re-attached and the conjunctiva is drawn together by a suture.

In the first case the site of the incision was easily seen the next day by the ophthalmoscope as a whitish line about two disc diameters in length.

Twelve days later a similar operation was done, but this time the external rectus was sectionized instead of the superior. There, however, remained permanently a very shallow separation which had not increased in size even four weeks later, when the field was found to be normal and the vision (c—7D and a weak cylinder) was $^6/_{18}$, some opacity in the vitreous being present.

In another case of high myopia in which detachment had existed for a year three post-equatorial incisions were made, which could afterwards be readily seen by the ophthalmoscope; the field became normal and the retina remained in good position.

In two other cases almost complete replacement was obtained.

In one old standing case no appreciable improvement could be noted.

In the last case recorded the tension before operation was — 3 and the condition looked hopeless but equatorial incision produced replacement and return of the tension to normal.

The author considers the procedure well worth further trial. It is not altogether free from the possibility of complication, as in the first case hemorrhage took place into the vitreous, and in another diplopia resulted from the cutting of the muscle.

At the time of writing, none of the cases had been under observation for a longer period than a month after the operation. (J. Gray Clegg in the *Oph. Review*, p. 160, May, 1908.)

The anatomic examination of a case of retinal detachment of eight days' standing, occurring with renal retinitis, is reported by von Hippel (*Oph. Year-Book*, p. 247, 1909). He found the underlying choroid distended, with evidence of thrombosis in the smaller vessels, with hyaline degeneration of their walls and endarteritis. Between the choroid and retina were suspended pigment cells. There was no alteration upon the vitreous surface of the retina. In another paper von Hippel reports two other cases of retinal detachment and discusses current views of its pathology. In one of his cases, occurring in a highly myopic eye, the vitreous was largely fluid, and traction on the retina was impossible. In addition the choroid was firmly adherent to the retina and also detached. In his other case the detachment may have started from a hemorrhage, which left considerable deposit, and the retina was thrown into folds, the detachment being funnel-shaped. These folds, he thinks, would point towards traction of the vitreous. In a detachment due to pressure from behind the retina the appearance would be that of a distended sail. The contraction of tissue on the inner surface of the retina he thinks would cause the appearance of a reefed sail. In considering the matter of

traction upon the retina, changes confined to limited portions of the vitreous, and in new-formed tissues springing from the retina itself, must be considered.

Lauber, in a report on 13 cases, concludes that the exudation theory best explains the detachments occurring with renal retinitis, hemorrhage behind the retina, and choroidal tumors. The supposition of traction on the retina seems more probable for cases following perforating wounds, with contracting exudate in the vitreous, or with proliferating retinitis or phthisis bulbi. Leber still regards as of great importance the contraction of new-formed cellulo-fibrous tissue upon the inner surface of the retina and within the vitreous. Wintersteiner reports a case in which the appearance of an intraocular tumor of yellowish-brown color, with darker points and cholesterin crystals, led to enucleation of the eye of a seven-year-old boy. Anatomic examination showed no tumor, but retinal detachment with the presence of inflammatory deposits and cyst formation.

Ulrich reports a case of spontaneous replacement of detached retina in a highly myopic eye. Walker reports a small detachment associated with moderate myopia. Wygodski demonstrated a case of recovery under rest and diaphoresis.

A case of full restoration of the field of vision after operation is reported by Paton. Two openings through the sclera were made with the cautery, followed by division of the retina presenting in the opening with a Graefe knife. The detachment involved the outer and lower part of the retina; and the scleral openings were made above and below the tendon of the external rectus.

Dor (*Oph. Year-Book*, p. 230, 1910) records a case of retinal detachment in the myopic eye of a nurse suffering from tuberculosis of the left apex. Under treatment with the tuberculin of Beraneck the retina became entirely replaced, and with correcting lenses vision of 3/10 was regained.

The treatment of detachment of the retina successful in a case of beginning detachment in the hands of Börngen, was injections of a solution of sodium iodid 1 : 1000; 40 injections were given in 3 months. The eye retained vision of 1/6.

Wootton reports a case of retinal detachment, treated by posterior sclerotomy guided by the ophthalmoscope. The retina appeared to become replaced, but a month later detachment recurred. Ellis admits that superiority cannot be ascribed to any one procedure. But he reports two cases of cure by evacuating the subretinal fluid with some vitreous, placing the patient flat in bed with both eyes bandaged for at least ten days, and using subconjunctival injections of salt solu-

tion, of increasing strength. One of the cases was operated on twice; the other four times. Other cases on which the treatment was tried were unsuccessful, most patients being unwilling to undergo the prolonged after-treatment. Thomson, in his extended review of the subject, finds it safe to say that though we may be somewhat nearer the correct pathogenesis than was von Graefe in 1854, we are no nearer certainty in treatment of retinal detachment than were Sichel and others at about the same period.

Bernard has collected from the literature (to 1911) records of twenty-four cases of retinal detachment occurring in the course of albuminuric retinitis of pregnancy, with subsequent reattachment, and in some cases a return to normal vision. In the case seen by the author, bilateral detachment was followed in two months by complete restoration with normal visual acuity. When death resulted from an accident a year later, no trace of chronic nephritis or of an ocular lesion could be found.

For the year 1912 *The Ophthalmic Year-Book* notes, among others, the following observations on detachment of the retina.

[As the Editor is convinced that experiments on animal orders below the higher monkeys are (owing to wide histological differences and for other reasons) useless and misleading in drawing conclusions applicable to human pathology no space is given to the elaborate reports on artificial detachment of the retina in dogs, rabbits, guinea pigs, etc., by Birch-Hirschfeld, Inouye and others.]

A case of detachment of the retina occurring during pregnancy is reported by Verderame. There was no albuminuria, but the patient had been extremely myopic. In the fourth month of her fourth pregnancy the retina became detached. Abortion was performed three weeks later, and twenty days after that the retina was restored to position, and vision and the field as good as before detachment.

Terrien reports a case in which detachment of the whole anterior portion of the retina occurred ten days after an iridectomy for chronic glaucoma. The detachment disappeared spontaneously fifteen days later without treatment. Hirschberg saw a spontaneous recovery of a detachment which had occurred twenty-one years after cataract extraction. Komoto reports a case of mild, sympathetic iridocyclitis, with detachment of the retina, in which the right became reattached after enucleation of the exciting eye.

Incurable diseases have the longest lists of remedies. To those suggested for retinal detachment Servel adds the use of remedies to reduce arterial tension, and reports a case "thus cured."

Ohm raised a conjunctival flap, made a short incision with the lance knife, aspirated the subretinal fluid and then injected air into the vitreous. Air bubbles appeared in the anterior chamber, but were soon absorbed. Of three cases thus treated one is reported as successful. Rohmer has treated eight cases by this method, and records one success and six cases of temporary improvement. The needle of the syringe is heated in a spirit flame, and the air drawn into it to sterilize it. He first introduces the needle through the sclera opposite the detachment. Then he opens the subretinal space with a Graefe knife, and thrusts the needle through the detached part of the retina, and injects the air into the vitreous. He used 1/2 c.c. of air as a maximum. In his successful case no detachment could be seen after four months. He thinks the injection of air also tends to cause the absorption of vitreous opacities.

Bettremieux incises the sclera subconjunctivally with a Graefe knife to the length of 10 mm. He exhibited at the Belgian Ophthalmological Society two cases cured by this method. Aurand has shown a case as cured after six subconjunctival injections of gelatin dissolved in isotonic serum, with 1 per cent. of acoin to avoid pain. Savage has used subconjunctival injections of sodium citrate, 15 minims of a 5 per cent. solution, and reports three cases greatly improved thereby.

That every detachment of the retina is caused by a disease of the vitreous body, which by shrinking is reduced in volume seems to be the opinion of C. Horstmann (*Deutsche med. Wochenschr.*, No. 47, 1910), an opinion, by the way, promulgated many years ago by Nordensen and Fuchs. To make up for this, serous fluid transudes from the choroidal vessels, which not being able to penetrate through the retina detaches it from the choroid. In many other cases the retina follows the direct traction of membranes and fibrillæ, newly formed in the shrunken vitreous. From the subsequent negative pressure under the retina liquid transudes from the choroidal vessels and accumulates between choroid and retina.

The different modes of treatment are discussed in detail with the following resumé: In all, especially recent, cases of detachment of the retina at first mild treatment ought to be attempted. Thus 4 out of 20 cases of Uhthoff were cured, and 14 out of 76 cases of Schmidt-Rimpler, while 28 were improved. Out of 50 cases of Horstmann, 7, i. e. 14 per cent., healed with good vision.

If this does not succeed, operative treatment may be indicated, which aims chiefly at diminution of the subretinal fluid, preferably by a puncture of the sclera in the area of the detachment. The writer urgently warns against methods which inflict an injury to the retina

or the vitreous tissue. In punctures of the sclera subconjunctival injections of salt solutions, not stronger than from 2 to 5 per cent., are recommended. All other operative procedures require the utmost precaution.

Differential diagnosis between idiopathic detachment of the retina, and detachment secondary to sarcoma of the choroid. In the idiopathic form the portion detached, when viewed with the ophthalmoscope, generally appears, according to Domec (*L'Ophtalmologie Provinciale*, Nov., 1908) as a grayish mobile surface, composed of folds and creases of undulations. Over all run the sinuous retinal vessels, arteries and veins, both showing darker than normal, and no sign of the underlying choroid is visible. In detachment secondary to a tumor—which is nearly always a sarcoma—the retina over it is smoother, i. e., not thrown into folds, the limits of the retinal separation are more sharply-defined, the whole is but slightly movable, or not at all, and the retinal vessels, save at the borders of the detachment, are much less tortuous. In short, its aspect resembles a sort of dome—more or less rigid. Unfortunately, these characteristics are by no means constant, but merge into each other in the two forms. The surface of the detachment must be studied minutely, with dilated pupil and very strong illumination, preferably by the direct method. By using a concave mirror held very close to the eye, and turning on various convex lenses, one can examine not only the surface, but one can, in a measure, look into the detachment, as it were. In this way, one may often see a second shadow pathognomonic of the presence of a neoplasm. When a detachment is situated between the equator of the globe and the ciliary body, and the signs just mentioned are not positive, the transilluminator may render great service.

Another sign of great value, when present, is a bloody infiltration of the detached retina, evincing a tumor. Minor signs are those, for instance, of location. A tumor is to be suspected when a circumscribed detachment appears at the vault of the vitreous chamber, or in the macular region. Detachment with hypertension, be it ever so slight, is suggestive of a tumor. So is slowly progressive failure of vision, instead of sudden or rapid; as is also the persistence of good or fair vision with a rather extended detachment. Close study of the field of vision may furnish a clue. The limits of the scotoma in simple detachment are less precise than are those of separation of the membrane due to tumor. Domec warns the examiner to remember that, in rare instances, the tumor is found diametrically opposite to the point where the detachment is located. Hence the importance of close scrutiny of the entire fundus.

S. Holth (*Wien. Med. Wochenschr.,* Feb. 3, 1912) is the author of the following procedure: After a meridional incision of the ocular conjunctiva, 10 mm. from the limbus, 10 mm. backwards between the external and the inferior rectus, a 2.5 mm. disk is cut out of the sclera with Bowman's corneal trepan. The conjunctival wound is closed with two sutures, which are removed after a week. The object is to keep the subconjunctival fistula open as long as possible. Eight clinical histories of cases so operated on are given in detail, which show that a detachment of the retina decreases in the course of a few months and may occasionally disappear entirely. The refraction of the highly myopic eye diminishes in the same space of time, and the antero-posterior axis becomes shorter. Holth believes that the supra-choroidal lymph oozes through the subtenonic fistula into the capsule of Tenon, which allows the thin-walled myopic globe to contract and lose in volume, aided by the exterior muscles. In detachment of the retina the same process favors the resorption by the lymphatics of the choroid, so that the subretinal fluid more or less subsides. If ruptures of the retina exist, so that the subretinal fluid communicates with the vitreous, the prognosis is less favorable. The beneficial effect of the operation was recognized by an enlargement of the visual field, while central vision was not improved. The results thus seem quite encouraging.

Birch-Hirschfeld (Graefe's *Archiv für Ophthal.,* Vol. 82, Part 2, p. 148, 1913), reports (1) that in twenty cases of spontaneous retinal detachment, including one case of sarcoma of the choroid, which had been treated unsuccessfully by conservative or operative methods, were treated by aspiration of the subretinal fluid, followed by injection of fluid through the retina into the vitreous, the fluid employed being either the subretinal fluid (Group 1, eight cases), or a mixture of subretinal fluid and .8 per cent. salt solution (Group 2, five cases), or .8 per cent. salt solution (Group 3, six cases).

2. In eight cases (four of the first, three of the second, one of the third group) a decided improvement with reattachment of the retina (retinitis striata), widening of the field and bettering of vision, followed.

3. In four cases there was slight improvement at the end of a year, in three cases no improvement, and in four cases a worse condition.

4. In six cases (three of the first and three of the second group) a more or less intense temporary inflammatory reaction followed the injection. In five of these, nevertheless, a marked improvement ensued.

Derrick T. Vail (*Annals of Ophthalmology,* Jan., 1913; review by

May in *Ophthalmology*, p. 600, July, 1913) communicated with 460 oculists of the United States asking for information as to whether they had had any success in curing any case of non-traumatic retinal detachment permanently, and requesting information concerning the treatment used. He received 281 replies, which he compiled in alphabetical order. Regarding results, 250 of the 281 never cured a single case; many had promising temporary results, but in the end failures. These failures represented probably an experience of 25,000 cases. On the other hand 31 oculists met with cures, 25 with a single cure each; in some of these the "cure" is not convincing and this leaves about 20 cases of cure, or less than one cure in every 1,000 cases.

In the light of such overwhelming evidence, the writer claims that vigorous treatment is inhuman, ought to be refrained from, and that we ought to resort to nothing but the mildest measures until we have a "cure" which cures.

He next advances the theory that in this condition there is a paralysis of the secretory function of the ciliary processes and that the secretion of aqueous is suddenly arrested; the ocular drainage channels remaining normal, the watery elements escape, thus causing minus tension, and this is followed by passive hyperemia of the blood vessels of the tunica vasculosa, permitting diapedesis and transudation; the vitreous contracts because it loses its percolating supply of aqueous. Continuing to explain his theory, he maintains that the subretinal transudation is highly albuminous; the watery elements ooze away and are replaced by fresh serum, a poor substitute for aqueous; the tissue colloids and circulating colloids imbibe all the moisture they can; the reaction of the transuded juices becomes altered to a less than normal alkaline or an actually acid state.

Vail next considers the causes of paralysis of the secretory function of the ciliary processes under two heads: acute local and systemic and chronic local. Acute local from concussio oculi, dazzling, certain drugs which paralyze secretory function, like belladonna, duboisin, etc., where the patient has idiosyncrasy or the preceding equatorial choroiditis, or myopia.

Acute systemic, from certain toxemias like those of albuminuria, diabetes, possibly acetone, indican, etc., which have a paralyzing effect on the delicate secretory function of the ciliary processes, or cause an acute inflammation of the cervical sympathetic nerves or ganglia.

Chronic local, from slowly progressive atrophy of the secreting epithelium of the ciliary processes, causing a gradual loss of function. This may result from equatorial choroiditis extending forward to

involve the ciliary processes, myopia of high degree, atrophy of the ciliary body in advanced presbyopia, etc.

In myopia the ciliary body becomes greatly atrophied from non-use; myopia is found in 60 per cent. of the cases of detachment. Age causes vascular sclerosis everywhere, and this leads to diminished physiological function; a sudden exciting influence may cause the ciliary body to lose its weakened function entirely. To reverse the argument: Given loss of secretion of the aqueous, what would result? Answered: Minus tension, deep chamber, dilated pupil, contracted vitreous and detachment of the retina. He believes there are many other arguments to sustain this theory, though he has touched upon only a few.

The author next considers the question of treatment. If arrest of secretion of aqueous is the cause we cannot expect any results from the many forms of treatment now in use. An attempt should be made to re-establish the aqueous flow by "alkalinizing" the intraocular fluids, which may be done by subconjunctival injections of sodium citrate after Fischer's ideas. Second, by inducing a return of normal aqueous secretion by local measures such as hot fomentations and general measures such as alkaline purgatives, sweats, sodium salicylate, pilocarpin and the iodides. Third, by treatment of the cervical sympathetic ganglion and nerves, by such agents as rubefacients, blisters, massage, electricity, general depletion and alteratives. These measures should be preceded by a good mercurial purge, followed by salts, rest in bed in a dark room, roller bandage to sustain the tension of the eye, for the minus tension prolongs the paralysis of aqueous secretion, and in fact all those measures and only those which have for their central idea the re-establishment of the secretory function of the ciliary processes.

MacNab (*Oph. Review,* p. 222, July, 1913) described a case of double detachment which underwent spontaneous cure. In another case in which the condition occurred there had been irido-cyclitis, and he believed it was due to tubercle of the eye; there was a large vitreous opacity, and very extensive detachment; the eye was very soft, being practically devoid of tension; the cornea could be seen to be dull and crinkled. Vision was reduced to mere perception of light. He gave tuberculin, and a vaccine cultivated from the patient's own coli bacilli. For four months now the tension had been normal, and the patient could count fingers at five or six metres.

A review of a major number of papers on detached retina for the year 1913 is copied from the *Ophthalmic Year-Book.*

A microscopic study of the retina of an eye removed for secondary

glaucoma is reported by Kümmell. He found degenerations and proliferations in the pigment epithelium, especially anteriorly, and also in the choroid, ciliary body and iris. He holds these characterize a clinical entity, which goes on to detachment of the retina, cataract and iridocyclitis. The retinal detachment is due partly to transudation behind the retina and partly to traction from the vitreous. Malz found non-traumatic detachment of the retina in 0.5 per cent. of all eye cases treated at the Tübingen clinic. The detachment was confined to one eye in nine out of every ten cases. It is extremely rare in the first ten years of life: three cases out of over 300. Not quite half the detachments occurred in myopic eyes.

Pagenstecher reports a family in which a man of 55 presented an old detachment of the retina with convergent strabismus and nystagmus. Two of his grand daughters, aged 6½ and 2½ years, cousins, were found to have detachment of the retina, and one of them convergent strabismus and nystagmus. All of the eyes were hyperopic, and in each case it was the right eye that presented the retinal detachment. He finds no other record of hereditary detachment.

Taylor reports a case in which both retina and choroid were detached, and where there was marked improvement with rest in bed and internal use of iodids. Chance reported the case of a lady past 50 subject to severe paroxysms of cough, in which the displacement was greatly reduced under treatment.

Sym's case of detached retina occurred three days after delivery in a patient who had suffered from retinal and general edema and eclampsia at the close of pregnancy. The retina was rapidly replaced, and vision of 6/18 was regained. Harman exhibited a case in which recovery from retinal detachment had occurred. The patient had complete detachment for three months, during which time she was treated by rest in bed. She had refused operation.

A case of cure of detachment in an eye myopic 8 D., by cauterization of the sclera to perforation, and subconjunctival injections of sodium chlorid, is reported by Teulières. Fehr reports the results of the combination of puncture with the compression bandage. The puncture was made with a broad cataract knife in an antero-posterior meridian, and the knife turned to 90 degrees. Following it a compressive bandage was so applied as to flatten the punctured eye from before backward. In five years he had thus treated 33 cases. In 19 the operation was performed once, in 11 twice, and in 3 three times. The first ophthalmoscopic examination showed reattachment complete after 22 of the 50 punctures. Five cases relapsed after more than three months, but 10 gave prospects of permanent cure. One

case, however, relapsed after remaining well for three and one-half years. Fehr considers this method of treatment contra-indicated in highly myopic eyes with a thin sclera.

Müller (*Oph. Review*, p. 324, Oct., 1913) presented two cases in which his operation of excision of a portion of the sclera in highly myopic eyes had cured retinal detachment. He reported that in one case atrophy of the iris had followed the operation, probably from injury to the long ciliary nerves. A distinct flattening of the eyeball was always produced, but the tension was normal.

Darier replies to Vail that of 60 detachments of the retina he had treated, 20 were improved, with the saving of more or less useful vision, and 6 were completely cured. He urges the subconjunctival injection of the gelatin serum containing: Acoin, 0.01; Gelatin, 0.30; Isotonic serum, 1. c.c.

Aurand reports a case benefited by simple sclerectomy. Elschnig reports of the operative treatment; of 18 cases by a simple puncture, 6 were somewhat improved, 1 cured and 3 made worse. Puncture and cauterization were done 42 times, on 29 eyes, of 27 patients; with one cured and 4 improved. Deutschmann's double puncture was done on 10, and Müller's exsection of the sclera, or modification thereof, 16 times; 11 eyes being somewhat improved. Puncture with injection of vitreous done 25 times on 22 eyes of 20 patients, gave improvement in 9 cases.

Walter Parker (*Trans. Am. Ophthal. Soc.*, p. 661, 1914), trephined three cases of retinal detachment, with a view to reduce the displacement. In the two previous instances he neglected to incise the choroid and retina, and the result was unsatisfactory. In this one he used a cataract knife to divide those coats, after completing the trephining; a marked reaction followed, but at the end of ten days the retina was re-attached, and the vision eight months after operation had risen from 4/60 to 6/12. The visual field is now nearly normal.

A similarly successful case was published by Flavel B. Tiffany in the *Ophthalmic Record* for March, 1914. The latter operator removed a small portion of the choroid with scissors, after trephining in the usual way.

A summary of A. Perlmann's (*Zeitschr. f. Augenheilk.*, p. 41, January, 1914) views is as follows: (1) Perforating injuries may lead to detachment of the retina, whether the eye is predisposed to detachment or not; (2) if detachment of the retina occurs in consequence of a new formation, the question arises whether this new formation is the consequence of an injury, which in most cases must be denied; (3) a blunt injury (concussion) is never capable of producing detach-

ment of the retina in a healthy eye; (4) quite a number of persons are, in consequence of ocular or general affections, constantly threatened by detachment of the retina. This occurs if the disease is sufficiently advanced, without external force; (5) if such a patient can plausibly prove an accident and a connection between accident and detachment, the etiologic connection will be affirmed in spite of considerable scientific doubts; (6) a severe strain during work can not be regarded as injury of the above kind.

In the treatment of detached retina C. Fehr (*Arch. f. Ophthal.*, Vol. 85, p. 336, 1914) regards equally distributed pressure, in the form of a pressure bandage, after evacuation of the subretinal fluid, as an effective agent for the cure of detachment of the retina. The bandage flattens the punctured eye from before backward; the contents of the eyeball are compressed, the vitreous presses the retina equally and permanently against the sclera (smoothing its folds) and the remnants of the subretinal fluid are expressed.

The puncture is performed, while the patient is sitting, with a broad cataract knife in a meridional direction, after which it is turned 90°. Within the last five years Fehr has treated thirty-three cases of marked detachment of the retina, without selection. They were twenty-two men and eleven women, aged from 16 to 73 years. Sixteen had excessive myopia, seven of slight or medium degree; ten, emmetropia. In five traumatism had preceded the detachment, one with perforation and loss of vitreous; four after myopia operations. In three cases the detachment existed for four weeks; in eighteen from two to three months; in six about six months and in six one year or longer. The operation was performed in nineteen cases once, in eleven twice, in three three times. After these fifty punctures the first ophthalmoscopic examination revealed a complete re-attachment in twenty-two instances, in sixteen, traces of detachment, and in thirteen, portions of detached retina remained; but the detachment was always less and the bluish projections disappeared.

In fourteen cases the operation was unsuccessful; in six, although a complete re-attachment was not attained, the patients were yet improved; in five, in which the operation effected a re-attachment, the patients had a relapse after three months and longer. Ten gave prospects of a permanent cure; the time of observation after the re-attachment was in two cases from three to four weeks; in two from three to four months; in one, a year; in three, one and one-half years; in one, four years and in one five years. The fact that a patient in whom the retina had remained in place for three and one-half years had a relapse, shows that one cannot speak of a cure even after years. Con-

sequently Fehr prefers the term "prospect of a permanent cure." The chances for a cure are the better the earlier the operation is performed. The writer never saw any injurious effect of the compressive bandage after puncture. He considers it contraindicated in cases of excessive myopia with a very thin sclera and projecting eyeballs, and in brittle vessels with a tendency to hemorrhage; also, if the detachment is flat and circumscribed without inclination to spread.

H. Maxwell Langdon (*Trans. Coll. Phys. Phila.*, Mar. 20, 1913) reported three cases of bilateral non-traumatic detachment of the retina. The first case was a man, aged twenty-two years, with the following history: His mother had her right eye enucleated when twenty years of age, following intraocular hemorrhage. When six years of age he had 4 D. of myopia; in the next year it increased to 6 D. in the right eye, and the retina of the left was completely detached, the eye being enucleated on account of intraocular hemorrhage. Six years later the myopia had increased to 6.50 D. in the right eye, and remained the same until seven years later, when the retina of this eye became detached. He was put to bed and the usual measures were taken, but without improvement. Subconjunctival puncture of the sclera was not done.

He has always enjoyed good health except for the fact that about once a year he had a major epileptic convulsion, the first, when he was sixteen years old. Wassermann test negative.

Case II was very similar. A man, aged twenty-two years, when ten years old was found to be blind in the left eye. He was seen by Loring, in Boston, who made a diagnosis of cataract and needled the lens, but the retina was almost completely detached and no vision resulted. In February, 1912, near objects were blurred and vision gradually fell, until, when seen nine months later, it was 2/60. At that time, the right eye showed a clear lens, some vitreous haze, a pale disk, and a completely detached retina except for a small area in the lower outer portion of the fundus. The disk level was about minus 3 D. and the general retinal level plus 12 D. He had always been well except for his ocular troubles. No Wassermann was obtained, as he was seen but once.

The third was a man, aged twenty-two years, who had chronic interstitial nephritis. Two years ago T. B. Holloway found his eyes to be normal in every way except for a low myopia. At that time, his blood pressure was 190. When seen by J. M. Griscom, two months ago, there was a moderately intense neuroretinitis in each eye with numerous hemorrhages and masses of exudate. Two weeks later, he had an unusual amount of retinal edema with wiry arteries and many

hemorrhages. When seen a fortnight later, the lower half of each retina was found detached and stretched across the lower fundus like a shelf on which the retinal vessels were seen as dark lines.

The myopia in the first two cases seems hardly to account for the detachment, as in the first case it was never over 7 D., and in the second case was but 3 D. in the eye last affected. It would seem that there must have been a congenital weakness in the choroidal vessels or possibly in the formation of the vitreous bodies. In the third case the detachment was undoubtedly due to a choroidal hemorrhage or subretinal exudate.

In reference to one of the cases whose history has been cited by Langdon, Holloway thought that in view of the age of the patient, and the fact that his eye-grounds were in good condition two years before he had come under observation with such marked retinal and vascular disturbance, that at least part of the pronounced changes in the vessels might be accounted for by assuming the existence of a denite amount of cerebral edema. Bramwell several years ago had again called attention to this possibility after his experience with a patient in whom the diagnosis rested between brain abscess and uremia. The patient was trephined, relieving many of the symptoms, but a subsequent study of the case showed it to be one of uremia. Following this, Cushing resorted to decompression in cases of nephritis.

Holloway also referred to the rapidity with which retinal and disk changes may occur in these cases, and stated that in several instances he had seen choking of the disk that he could not definitely differentiate from the condition that might be produced by an intracranial growth.

Posey spoke of the significance of detached retina in disease of the retina caused by Bright's disease, and said that it was a most unfavorable symptom, as its occurrence was usually followed by the death of the patient. He had recently seen an old man in apparent good health, with hypermetropic eyes, and who had suffered no traumatism, in whom both retinas were detached. He had been unable to find any cause for the retinal condition.

Leonard W. Jones (*Journ. Am. Med. Assocn.*, p. 331, Jan. 23, 1915) points out that detachment of the retina, as a result of serous effusion following a lesion of the kidney, is an exceedingly rare affection. The author, however, is able to report the following case:

W. K., a telegraph operator, who had five years ago been treated for "kidney trouble" and was thought to have been cured, about the second week in February, 1914, noticed a blurring of vision. This

rapidly increased and he found himself unable to read the manuscript of his work. This attack was accompanied by headache and vomiting. The physician whom he consulted diagnosed his condition as glomerular nephritis and an oculist to whom he was referred found albuminuric retinitis present in both eyes.

The examination of the eyes disclosed the following condition:

Right eye: Vision reduced to perception of light; pupil dilated and did not respond to light. Rotation of the eye was normal. Beyond the dilated pupil there was no external evidence of an eye lesion.

Fundus: There was a grayish reflex; the optic nerve was decidedly blurred, veins swollen and tortuous. At the region of the macula there was the characteristic appearance of albuminuric retinitis. Running in an inverted horseshoe fashion and beginning about two nerve-heads' width below the papilla was an elevated tumor giving a grayish-green reflex and seen best with a plus 12.00 lens behind the ophthalmoscope. On top of this tumor were markedly tortuous small blood-vessels. Tension was normal, or if anything, very slightly elevated. The left eye was practically the same as the right. Three days later, a second examination. The area of detached retina now extended above as well as below the optic nerve, so that the only attachment of the retina was around the circumference of the papilla. The patient maintained that his vision was somewhat improved, although a test made did not tend to confirm his belief.

Transillumination showed a clear glow, eliminating the remote possibility of a solid tumor, as the cause of the detachment.

Urinalysis: Color, usually light amber, occasionally dark. The specific gravity was 1.002. The albumin ring was well marked. There was no sugar. The sediment was granular, and there were hyaline and epithelial casts, as well as kidney epithelium. The phenolsulphonaphthalein test showed an excretion of 15 per cent. in two hours.

Systolic blood-pressure was 210.

There was no edema of ankles, swelling under the eyes, ascites or evidence of serous effusion elsewhere in the body. It may be of interest to note that one married sister had an attack of albuminuria with her last pregnancy. The patient died, April 23, 1914.

Weeks cites a case very similar to the one just reported.

Thomas H. Curtin (*Ophthalmic Record,* February, 1915), reports a patient who showed in the left eye a large detachment of the lower and outer part of the retina, without a history of trauma. No improvement took place under medicinal treatment. A scleral button of 2 millimeters was then removed over the site of the detachment, as far back as possible, between the inferior and external rectus muscles.

The choroid and retina were not punctured at the time. A moderate pressure bandage was applied, and the patient was put to bed for ten days. No change took place.

Next, twenty-five minims of fluid were withdrawn from the sub-retinal space with an aspirating syringe. The retina then fell back into place, and there was no reaction following.

The vision of the eye improved from hand movements to 20/30. The field became normal. The conjunctiva over the scleral opening continued to show a slight chemosis. The last observation reported was some six weeks after the aspiration of fluid, and the retina was still reattached.

The writer prefers aspiration to incision of the choroid and retina as practised by Parker and others, as it produces less traumatism, no injury to the retina, no loss of vitreous and no marked reaction. Also, the procedure may be readily repeated.

H. L. Eason (*Lancet*, January 2, 1915), reports a case of spontaneous reattachment of retina in a highly myopic eye. With the exception of a posterior staphyloma, and the rather thin choroid of high myopia, the interior of the eye was normal in every respect. He does not know that any satisfactory explanation has been given of the fact that in cases of detachment of the retina, vision only remains in abeyance and is restored immediately the retina once more comes in contact with the choroid. The loss of vision can hardly be due to any failure of vascular or lymphatic circulation, as under these circumstances the retina would degenerate rapidly after detachment, and recovery after an interval of any length would be impossible. The retina always strips away, leaving the layer of pigment epithelium attached to the choroid, and it seems probable that without the pigment epithelium, and possibly the visual purple, the other layers of the retina cannot perceive light.

R. R. James (*Ophthalmic Review*, Jan., 1915), reports the case of a myopic patient, aged 44 years, who received an injury to one eye when 25 years old, in consequence of which the retina of that eye became detached. No treatment. Eight years after the injury, the lens of that eye was opaque, and perception of light was absent.

Sixteen years after the original accident, the retina of the other eye became detached, possibly as the result of severe coughing. From November 23, 1912, to December 28, 1912, the patient was kept in bed flat on his back. On the latter date he was allowed a pillow. After November 30th, subconjunctival injections of normal saline were given twice a week. On January 3, 1913, the patient was allowed to get up, as there had been considerable improvement during

the six weeks' rest in bed. On January 29, 1913, the vision of the affected eye with minus 13 D. sph. was 6/60. No detachment was visible but there were "floaters" in the vitreous. In July, 1914, V. (corrected) was 6/12 (letters), about the same as it had been before the retina became detached.

James modestly classifies this result as one of "spontaneous healing."

Charles Higgens (*Lancet*, Sept. 12, 1914), describes three cases of recovery from retinal detachment studied during his extended professional career. He deprecates operative procedures, holding that the treatment that holds out the best, if only a slight, hope of cure, is by rest in the horizontal position continued for weeks, and measures supposed to cause removal of fluids: such as sweating, purgation, absorbents, and abstinence from fluid nourishment as far as it is possible to live without it. He adds that he has reported the cases as recoveries from detachment of the retina, which is a fact; but has grave doubts as to whether the result was due to the treatment adopted, or was merely coincident with it.

Leslie Paton (*Trans. Oph. Soc. Un. Kgdom.*, Vol. 35, 1915), also reports three cases of healed detachment of the retina. His first case was that of a female, in whom, in 1908, rest treatment had been carried out. She had six weeks in bed, with hot air baths, mercury and potassium iodide, and six weeks on the couch. At the end of that time the detachment had completely subsided. She had since remained quite well.

The second case was that of Miss P., aged 41. There was an old detachment in the left eye. Detachment occurred in the right eye early in June, 1907. Paton operated in August. The detachment was large and on the nasal side. After the operation by the galvanocautery, the detachment went back into position on the nasal side, and an almost equally large detachment appeared on the temporal side. On September 9th operation on the temporal side: patient kept in bed till mid-October. By November the V.A. was not much improved, but in 1908 it had improved to 6/18. Now, eight years after the operation, V.A. 6/9 with —16 D., the original myopia in 1907 having been 15 D.

Paton's third case was that of a gamekeeper who in 1907 had an old detachment in the right eye and a recent one in the left eye with V.A. 3/60. Paton had performed three operations by the galvanocautery on this left eye, with the result that in August, 1910, V.A. was 6/9 and since then, has varied between 6/9 and 6/6.

Maitland Ramsay (*Trans. Oph. Soc. Un. Kgdom.*, Apr. 1915), finds

that after having tried many different operative methods he cannot recall a case where operation alone did any permanent good. At the same time he considers that the view of constant incurability held by Leber and by Vail is too pessimistic. Apart from spontaneous cures of the detachment he refers to the view that practically every clinician is familiar with the fact that a patient's vision may improve decidedly even although a considerable separation of the retina exists. Improvement of this kind may be due to increased transparency of the media, or to the settling down of a detachment to a peripheral part of the field. Though such cases are not cured, yet from the patient's standpoint an improvement in sight is much more to be desired than an anatomical replacement of a retina whose function has become seriously impaired.

Ramsay advises as the most satisfactory form of treatment absolute rest in bed (not necessarily in the same bed all day) for from four to six weeks. During this time the patient should be made as comfortable as possible, and everything must be done to ensure his good health, while all possible causes of straining must be avoided.

Ramsay also relies on a pressure bandage and atropine, and subconjunctival injections. Remove the pressure if it does not agree with the particular eye in question. The third place of honor is occupied by subconjunctival injections. If the site and the character of the detachment appear favorable the subretinal fluid is first evacuated by scleral puncture, and at the same sitting a subconjunctival injection, consisting of five to twenty drops of a solution containing 1 per cent dionine and 8 per cent. chloride of sodium (chemically pure) in 1 in 2000 bicyanide of mercury. Pain may be avoided by the addition of a few drops of 1 per cent. acoine or 2 per cent. alypin solution to the injection fluid immediately before use. The injection fluid should be heated and a fomentation applied to the eye immediately after the operation. In about a week the chemosis has disappeared and the eye is ready for another injection. The average number given by Ramsay is from four to six. Where little improvement appears after a fortnight, diaphoresis by means of pilocarpine (with strychnine if necessary) may be employed. Wherever possible the patient should not return to work as soon as he is allowed up, but ought to have a change of air. In travelling he must endeavor to avoid jarring of any kind as much as possible.

Ramsay draws our attention to cases in which cataract forms in an eye which has suffered from detachment and in which the fellow eye is useless. These are not as hopeless as one might imagine, since the retina sometimes becomes attached after the lens becomes cataractous.

The cataract may be extracted, though there is great risk of irido-cyclitis and ultimate loss of the restored sight. In these cases Ramsay performs simple extraction under a conjunctival bridge.

M. S. Mayou (*Oph. Review,* p. 181, Jan., 1915), in opening a discussion of the subject at the annual meeting of the Oph. Soc. of the Un. Kgdom., said that detachment of the retina is only a sequel to other intra-ocular diseases. He dealt in the first place with its associated physical phenomena, and, secondly, with congenital detachment especially. The condition was really one of separation of the retina between the pigment-cell layer and the rods and cones, i. e., where the two layers of the optic cup come together during fetal life, and which was subsequently represented as a lymph space. Detachment of retina was essentially a cystic condition. The author was strongly in agreement with von Graefe's view that it was exudative in origin, and that detachment could not occur without fluid being effused from the choroidal vessels, the fluid having a higher specific gravity than that in the vitreous chamber. It was probable that there was no true tissue adhesion between the rods and cones and pigment-cell layer, or at least so slight that it was not a factor in keeping the retina in its place. This potential space was filled with lymph, permitting the rapid tissue change associated with the bleaching and regeneration of the visual purple. In the normal eye distension of the vitreous in its hyaloid was by fluid derived from the ciliary process; the vitreous exerted a pressure by having a higher density than the lymph in the inter-retinal space. In many diseases the vitreous became more fluid than normal, or the framework of the vitreous shrank with the hyaloid, and there was free fluid in the space between hyaloid and retina. With degeneration of the vitreous the densities of the fluids on the two sides of the membrane closely approximated, and a slightly increased density of that in the inter-retinal space would produce detachment. For the investigation of such cases it was necessary to use a fixing agent which coagulated but did not destroy albumen; and boiling was the best. It was very difficult to ascertain the underlying cause of shrinkage of vitreous. Detachment of retina occurred when a larger pressure was exerted outside than inside the membrane. Detachment could occur with a normal vitreous, as when the choroid was the seat of a growth. Owing to the effusion of albuminous fluid the retina was pushed inwards, and some of the fluid was squeezed out of the connective tissue meshes, passing forward into the anterior chamber. Glaucoma might supervene before the complete shrinkage of the vitreous. Detached retina associated with growth in the choroid was exudative in character, though it might cause sec-

ondary changes in the vitreous. He detailed some cases in children who had come under his care. In myopia a fluid exuded into the inter-retinal space of low density would cause detachment, possibly associated with venous obstruction. Inflammatory exudation from the choroid might cause detachment if of serous rather than plastic nature. Injuries might cause detachment, either with or without perforation of the globe. Fibrous bands in the vitreous he thought rarely caused detachment by contraction, though they might predispose to it by causing shrinkage and fluidity of vitreous. Cysts in the retina in its normal position might be of considerable size, and by bulging cause detachment on either side. Some of the cures of detachment he thought were probably due to evacuation of the fluid contents of these cysts. Congenital detachment was not usually recognized, as it occurred in microphthalmic eyes, and was not then seen clinically. Summarized, the author's contention was that the essential feature in congenital separation between the layers of the retina was distension of the primary optic vesicle with fluid, and that the fibrosis of the vitreous was of secondary development, not the cause of failure of union between the inner and outer layer.

The speaker further pointed out that so long as the pathology of any disease was obscure its treatment must be empirical, and frequently ineffectual. This was the present-day attitude in regard to detachment of retina, which was really a terminal effect. In cases of tumor of choroid, detachment was caused by accumulation of edematous fluid behind the retina, this fluid being an irritative product. In some cases the cause was a perforating wound of the sclera, a case of which he quoted. Sometimes the detachment was due to a rapid exudation of lymph and serum into the sub-retinal space in severe choroiditis or general uveitis; or it might be caused by sub-retinal hemorrhage. He believed that detachment might occur from cicatricial contraction of the retina itself. From an examination of different types he thought it safe to conclude that symptomatic detachment might arise from either a push from behind, a pull from inside, contraction of the retina, or a combination of any of these factors. He reminded the meeting of the main contentions of Raehlmann and Leber, and said that most cases of simple detachment occurred in myopes; he had found it to occur in all degrees of myopia, in which condition there was an increased cubical capacity of the scleral cavity. Vail, of Cincinnati, had shown that in myopes the circular ciliary muscle was usually atrophied from non-use, and that authority considered it part of a generalized atrophy of the ciliary body, with diminution of aqueous secretion and lowering of ocular tension. Paton

then proceeded to discuss the question of sympathetic detachment, stating that he considered it a moot point as to whether it was really sympathetic, or whether the action was a setting up of a chronic cyclitis or uveitis in the sympathizing eye. He had had some cases of cure, i. e., restoration of function, and he realized that spontaneous cure sometimes eventuated, though similar cases left alone had not got well, as had the cases in point after his treatment. In every case he thought all the facts should be placed before the patient, so that he could decide on whether he would have anything done or not, especially as knowledge on the subject was not yet complete enough to enable a safe prognostication to be made in any particular instance.

Edgar Thomson and T. H. Curtin (*Journ. Am. Med. Assocn.*, p. 330, Apr. 1916) refer to the suggestion of Iwanof, that in highly myopic eyes detachment of the vitreous humor occurs at the posterior pole, because the vitreous cannot increase in volume as rapidly as the posterior part of the sclerotic is distended. They regard this theory as untenable, because it is not borne out by the fact that detachment in myopia does not always occur at the posterior pole, and that the vitreous does rapidly increase in volume through the imbibition of serum. Moreover the status of "retinal rents" has not yet been satisfactorily established.

The authors reject the Fisher hypothesis as applied to retinal separation and believe that the clinical evidence is in favor of the choroid as the origin of the subretinal fluid, and conclude that, in the present state of our knowledge, we are not justified in assuming anything more than that retinal detachment occurs as the result of a lymphatic derangement leading to exudation from the choroidal vessels. They also emphasize the importance of making a clear distinction between cases in which inflammatory symptoms antedate the detachment and those in which the detachment antedates the inflammatory symptom. Surgically, they believe it is important not to incise the choroid, lest it lead to reaction and vitreous hemorrhage. They suggest that aspiration be substituted for incision of the choroid after the sclera has been trephined.

The operation (see Curtin, *supra*) is described as follows: A curved incision is made through the conjunctiva, with the convexity in the direction of the cornea, and the tissues are taken up down to the sclera. It is wiser at this juncture to put in a single silk suture at the summit of the flap, as otherwise the capsular tissue underneath the flap is apt to be rolled up and the ultimate flap will then be composed of nothing but conjunctiva, leaving more or less thickening and adhesions of the episcleral tissues, which tends to seal up the trephine

opening. The entire thickness of tissue is taken up down as far as the sclera, and dissected well back. The assistant then holds this flap back by means of the suture. The trephine opening is then made with a two or three millimeter trephine. We are of the opinion that a larger opening is better, but experience is necessary to decide this point. On the removal of the trephine button there is in many instances a gush of serous fluid from the suprachoroidal space. Examination of the eye usually shows considerable subsidence of the detachment after this fluid has escaped. The flap is then sutured into place and the eye bandaged and the patient put to bed. It goes without saying that the pupil should always be well dilated with atropin before the operation, both for purposes of examining and to keep the eye as free as possible from the tendency of inflammation. There is usually very slight reaction after the trephine operation. In a week or ten days later the patient is put on the operating table and the needle of a small aspirating syringe is inserted into the subretinal space, through the conjunctiva and choroid. The subretinal fluid is then forcibly aspirated, after which the patient is put to bed for a day or two, as circumstances require. The aspiration operation is followed by practically no reaction and can be repeated as long as the trephine opening remains free. In this connection it is very important to have the flap properly made, as if capsular tags are allowed to roll up under the flap, it is difficult to see where the opening lies, and to enter the needle requires a great deal of stabbing around in the dark. If the conjunctival flap heals properly the trephine opening shows as a small dark spot, which is easily identified.

Three cases are reported, the results showing improvement in vision in two cases and no improvement in one.

J. Ohm (*Zeitschr. f. Augenheilk.*, 33, p. 288, 1915), is an advocate of scleral trephining in detached retina and cites the history of a man, aged 42, whose congenital nystagmus had been aggravated by miner's nystagmus, and who showed a flat detachment of the nasal portion of the left retina with a large horseshoe-shaped rupture, covered with hemorrhages. V. with − 5.00 = fingers at 4 m. After keeping quiet for five weeks the detachment was found to be also downward and outward. Six weeks later it occupied the whole lower half of the retina and showed grayish-white folds. V = fingers at 3 m. A bridle suture was made through the conjunctiva near the lower limbus, in order to be able to roll the eye well upward. A triangular conjunctival flap was turned downward and outward; trephining of the sclera with Elliot's trepan downward and outward, about 9 mm. from the limbus, with evacuation of considerable subretinal fluid; suture

of the conjunctiva; pressure bandage; rest in bed for a few days completed the treatment. The first ophthalmoscopic examination after four days showed complete re-attachment of the retina. After three weeks V with correction= 4/30; after five months 4/18; visual field normal.

Ohm thinks that trephining evacuates the subretinal fluid more thoroughly and permanently than simple puncture with von Graefe's knife; it also avoids injury of the retina. He believes that in future one will decide upon early operation, as aside from the advantage of the detachment downward the situation is deteriorated by postponement.

S. Holth (*Norsk Mag. f. Laegevid.*, June, 1915), is still a firm believer in the efficacy of pre-equatorial sclerectomy in most cases of retinal detachment. He has not seen a single case of spontaneous cure of primary retinal detachment in the course of twenty-four years. In the past two years he has told every patient with rents in a retinal detachment that he had never seen a single recovery in such cases. In Holth's opinion, if pre-equatorial sclerectomy is reserved for the detachments in which, after repeated painstaking ophthalmoscopy under atropine mydriasis, no rent can be discovered even at the utmost periphery of the fundus, more cures will be achieved by this method than with any other treatment which he knows. It may be argued that such cases offer a relatively good prognosis with non-operative or other forms of operative treatment. But pre-equatorial sclerectomy has a great advantage as compared with most methods of treatment, in that when it does produce complete cure this is apt to come suddenly, which is of the greatest significance as regards the best possible re-establishment of the retinal function.

Ingolf Schiötz (*Norsk Mag. f. Laegevid.*, April, 1915), furnishes additional evidence in favor of pre-equatorial sclerectomy in this disease. He says that since 1911 every case of retinal detachment in Hjalfdan Schiötz's clinic has been treated by Holth's method of pre-equatorial sclerectomy. The present report covers the first nineteen of these cases and two of Hjalfdan Schiötz's private cases. After making a conjunctival flap outward and downward, a meridional cut is made in the sclera with a modified Graefe knife. As the choroid is approached, a suitable opening is cut in the sclera with Holth trephine scissors. Sometimes the choroid was intentionally cut, sometimes not, and sometimes the subretinal bleb opened itself spontaneously. Sometimes instead of trephine scissors a two and one-half millimeter Bowman's trephine was used. In no case was a postoperative reaction observed. Dressings or compressive bandages were never used, the

eye being merely covered with an aluminum shield. Five of the twenty-one patients showed improvements, nine remained in the status quo ante, and six were worse, at the time of discharge from the hospital. At later examination three showed improvement, five maintained the status quo ante, and eleven were worse. The results under this treatment were not strikingly better than after other operations, but they were by no means worse; and as no better treatment is available, Hjalfdan Schiötz has continued to employ pre-equatorial sclerectomy, usually combined with the horizontal position both before and after operation.

R. R. James (*Ophthal. Rec.*, Jan., 1915), details a case of probable spontaneous cure of retinal detachment in a male, age 44, who eighteen years previously had an injury to his left eye. Three days before admission to hospital he had a severe coughing spell, and two days later could not see properly with his right eye. Pupil reacted to light. Tension was normal. A large detachment was present in the lower part of the eye, the field being diminished upwards. There were a few coarse vitreous opacities; no hole in the detached retina. Vision was 6/60 with —13.0 sph. The left eye was divergent, absolutely blind, with a yellow, chalky-looking opaque lens and some recent hemorrhage in the anterior chamber. The tension was slightly increased.

The patient was put to rest flat in bed, his head steadied between sandbags, a cough mixture prescribed, and, after the first week, was ordered subconjunctival injections of normal saline solution twice weekly.

A year and eight months later his vision was 6/12, the field showed only a slight contraction downwards, due to a patch of choroiditis in the upper part of the fundus.

The writer emphasizes the point that detached retinæ do occasionally re-attach themselves; and that the treatment for detachment by puncture or cautery rarely leaves an eye with a good visual result.

He does not think the subconjunctival injections were of any material service.

An additional example of spontaneous re-attachment of the retina, after a lapse of twenty-two years, is reported by A. Edward Davis (*Ophthal. Rec.*, October, 1915). The patient, aged 18, was first seen Aug. 12, 1897, with the history of a fall from a carriage when six years of age, striking the left side of the head. The writer is of the opinion that a choroiditis of a tuberculous nature developed subsequent to the traumatic detachment, and that with the improvement of the patient's health when in the country, the choroiditis subsided and

in the healing process the retina was again bound to the choroid. Davis is inclined to favor non-surgical treatment in these cases.

Summary. One who has made a study of the observations of others in the surgical treatment of detached retina and has added to it his own experience—though that may be limited—will, doubtless, come to these conclusions: 1. Inasmuch as separation of the retina is not a distinct disease but merely one sign—albeit a very important one—of several different affections, it is not to be expected that it is to be cured or much relieved in every instance by some particular operation. The "one-disease-one-operation" idea can have no place here. 2. A large percentage of retinal repositions, including an unknown proportion of those that follow operative measures, belongs to the class of "spontaneous cures." In such cases relief may have been assisted, hastened or rendered more or less permanent by the remedies exhibited, but the probability is that the patients would have recovered in any event. 3. So far as prognosis is concerned, the more hopeful cases are the recent, limited varieties—those produced by traumatism, post-retinal hemorrhage and the like—as well as those resulting from removable causes. Per contra, old, extensive detachments, especially when associated with marked degeneration of the retina, vitreous and choroid, are not likely to get well under any forms of treatment. A long-separated, starved retina rarely regains its lost functions. 4. Recurrence of the detachment forms a disappointing feature in the treatment of the disease and this fact should be considered by both patient and surgeon when the subject of operation is broached. On the other hand, it has been abundantly demonstrated that cases of separated retina have recovered after several relapses and after the patient has submitted to many operations. 5. No case should be regarded as permanently cured until at least a year after the replacement of the detached membrane. It is true that relapses are recorded after an interval of several years, but they are unusual. 6. When a patient presents himself it is best to try for, say, a month—indefinitely as long as improvement continues—non-operative measures. A thorough study should be made of the case to determine, if possible, and to treat the cause of the retinal detachment. With this indicated therapy one should give subconjunctival injections, instil atropia and keep the patient in bed. Pilocarpine sweats, with iodides or sodic salicylate, are also generally indicated.

7. Failing to improve vision or to replace the separated retina by milder means, resort should be had to operation and the question of the best operation for the case in hand at once arises. We know that the function of the retina gradually weakens the longer it is displaced,

consequently, the sooner one makes a choice of operation the better. 8. Deutschmann advises against his operations as long as the post-retinal fluid is held within the upper quadrants of the globe. If we are debarred by this circumstance from the use of his methods, there can be no objection to the employment of scleral puncture, combined with punctiform cautery of the denuded sclera over the site of the detachment. Why should we wait until the retina is further detached and degenerated? 9. In the event of failure by other operative measures and in those cases where the sac occupies, as it generally does, the lower aspect of the hyaloid chamber, Deutschmann's method of bisection should be the operation of election, whether or not there be evident rents in the retina or visible fibrillæ in the vitreous. 10. Two weeks after an intrabulbar operation a careful examination of the eye should be made—with the electric ophthalmoscope (so that the patient may keep the prone position), hand perimeter, ward charts, etc.—to decided if improvement has taken place in the local conditions as well as in central and peripheral vision. 11. Assuming the eye to have recovered from any operative measure, i. e., to be free from either intra- or extraocular inflammation, the same or another operation may be done in from three to six weeks' time. 12. In unpromising cases Deutschmann's intraocular injection of animal vitreous is in order, but it is to be considered as a last, desperate resort.

Birch-Hirschfeld (*Deutsch. Med. Wochenschr.*, Feb. 6, 1919; abs. *Journ. Am. Med. Assocn.*, May 31, 1919) reports his experiences with 142 cases of detachment of the retina between 1900 and 1910, with reexamination of most of the patients later. With spontaneous detachment of the retina, seen early, he applies in treatment bed rest, injection of saline and other mild measures, hoping for spontaneous reposition of the retina. If no or very insignificant improvement is observed, he proposes operative measures if the detachment affects the lower part of the retina, if the refracting media are clear enough for ophthalmoscopic supervision of the operative procedures, and if the pressure in the eye is not too much reduced, and there is no extensive tear in the region where it is proposed to operate. The functional capacity of the detached and the still adherent retina must be such that appreciable improvement is possible. The relatively slight chances for success must be fully explained to the patient beforehand. The first thing to be done is to remove the subretinal fluid. For this he prefers to trephine, cutting out a small disk, 1.5 to 2 mm. in diameter, and then aspirating the fluid. The retina can be seen then returning to its place, and with a compressing bandage it can be held

in place, hoping it will become reattached. This actually did occur in 5 of 25 patients thus treated, and slight improvement was manifest in 5 others, but in 15 the progressive course of the detachment was not checked. Better results were obtained when he injected a fluid into the vitreous body to exert pressure on the retina. Various fluids have been used for this purpose, but he thought that the logical fluid for the purpose was that which he had just aspirated from back of the retina. As this fluid usually contains much albumin, up to 26 per thousand in his cases, he diluted it with a little saline, and thus could inject a somewhat larger volume than he had aspirated. He has applied this procedure in thirteen cases, all quite severe, refractory to milder measures, and comparatively favorable results were realized. In six of the cases there was more or less inflammation in consequence, in the interior of the eye, and this may have contributed to the favorable outcome as five in this group of patients were essentially improved. At the same time it worries the physician to behold this inflammatory process develop in a previously noninflamed eye, as exact dosage of the irritation and guarantee of its harmlessness are out of the question. Consequently in his later series he has restricted his intervention to trephining, aspiration and the compressing bandage. A spontaneous cure has been known in only about 1 per cent. of the cases of detachment of the retina on record. Mild measures were successful in about 5 per cent., and slight improvement was realized with them in 6 per cent. In 89 per cent. they failed completely. Puncture with or without electrolysis and section realized essential improvement in 4 per cent., slight improvement in 25 per cent. and no benefit in 71 per cent.

Retina, Development of the. See p. 3902, Vol. V of this *Encyclopedia.*

Retina, Echinococcus of the. This entozoon is (Leber) very rarely seen in the retina. *Vide* p. 4123, Vol. VI of this *Encyclopedia.*

Retina, Edema of the. See **Commotio retinæ.** In addition to the traumatic form of th's condition a hazy, serous exudate (see **Retinitis, Serous)** into the retinal tissues may accompany embolism of the central artery, glare of the sun, lues and other pathologic states. The grayish haze (that may extend into the vitreous) obscures the details of the fundus picture. It may show as a dense whitish patch, most marked at the macular region, shading off towards the periphery. It is often associated with the well-known "cherry spot" (p. 2033, Vol. III) even when the remainder of the retina is unaffected. The treatment is, of course, that of the underlying cause. See, also, **Retina, Injuries of the.**

Retina, Embolism of the central artery of the. See p. 4287, Vol. VI of this *Encyclopedia.*

Retina, Fatigue of the. A state of diminished excitability of the optic nerve following continued excitation.

Retina, Filaria of the. An extremely rare parasite of the retina. See **Parasites, Ocular.**

Retina, Foreign bodies in the. Foreign bodies in the retina must first pierce the outer envelopes, either passing through the cornea, sclerocornea or sclera, injuring thereby in their passage the lens, iris, ciliary body, choroid and vitreous, and being directly impacted in the retina of the opposite side. The larger proportion of foreign bodies are splinters of steel or iron, then come copper chips and shot pellets.

If the media be sufficiently clear a small, dark, metallic, glistening object will be seen in the retina, surrounded, in recent cases, or imbedded in a hemorrhagic clot which extends into the vitreous, or in older ones with a whitish or yellowish region of swollen retina. Later on the foreign body is imbedded in a yellowish-white organized exudate with whitish, degenerated choroidal spots in the neighborhood, with or without pigment proliferation. Fine changes occur in the region of the macula in the shape of irregular lines or spots of pigmentary degeneration. In some cases localized detachment of the retina and shrinking of the vitreous are observed.

Splinters of iron are rapidly encapsulated in the retina and useful vision may exist for a long time before further degeneration or irritation sets in, or it may remain good for the life-time of the patient.

The foreign body may remain for a long while encapsulated and then work out into the vitreous and cause fresh inflammation.

Particles of iron may so rust that they become non-magnetic. If they are septic an acute abscess of the vitreous and loss of the eye from panophthalmitis speedily occurs.

Copper chips cause immediate suppuration when in the retina, just as they do in the vitreous. In only a few instances have they become encapsulated and some vision been retained, and as a consequence of this action and their non-magnetic qualities, most eyes retaining copper in their depths come to speedy enucleation. Other foreign bodies, if aseptic and having no special chemical reaction, act much like iron and are sometimes encapsulated.

The tolerance of the retina to iron and copper splinters is much greater than that of the vitreous, though less than the lens. The encapsulation occurs through proliferation of connective tissue cells of the retina and may completely cover the particle from observation. If very great it extends into the vitreous causing opacity and shrinking,

with subsequent detachment of the retina, especially when the splinter is quite large.

Four dangers threaten the eye containing iron or copper particles in the retina. 1. Retinal detachment. 2. Recurring severe attacks of inflammation. 3. A form of inflammation which leads to retinal degeneration and blindness in which the disease looks like retinitis pigmentosa with hemeralopia, but the pigmentation is not so prolific. 4. Changes at the macula (in most cases of iron in the eye), eventuating in macular affections which rapidly diminish the vision causing central scotoma. The fovea becomes yellowish-brown and the surrounding retina dark-red.

Only when the splinter itself can be seen by the aid of the ophthalmoscope may we be sure that it is in the retina, although the X-ray is a fairly accurate method of localization. The chip of metal appears black or has a metallic lustre; after it becomes encapsulated it is covered by whitish, well-defined, connective tissue membranes.

When the injury is new it is accompanied by streaks of blood in the parenchyma of the retina and in the vitreous; later pigment accumulates in the neighborhood of the foreign body. If no inflammatory symptoms occur, when a foreign body is known to be in the posterior portion of the globe, it is probable that it is in the retina and has become encapsulated.

Prognosis is better than in the case of the vitreous, for small splinters may become encapsulated and leave clear vision. If not removed or the eye be not enucleated the patient must be warned that not only loss of sight may occur from subsequent inflammation but even loss of the eye, with danger of sympathetic ophthalmitis.

Iron particles are more difficult to remove by the magnet when in the retina than when in the vitreous, because they are often strongly impacted, even into the subjacent sclera. Copper and other foreign bodies offer a poor prognosis, as they are difficult and generally impossible to get out and nearly always cause inflammation and ruin of the eye. They do not generally become encapsulated, hence rendering enucleation necessary.

If the particle be iron, if it has recently entered the eye, if the wound be open and the foreign body localized by the ophthalmoscope, the sideroscope or the X-rays, it may be immediately extracted by the magnet through the wound, after either the method of Haab or Hirschberg. If the wound be closed it is well to instil atropin and after definite localization make a new incision posteriorly and extract the chip by the aid of the magnet.

If the injury be old and the chip encapsulated the eye should be

left alone until symptoms of irritation occur, when an attempt at removal may be made, followed, if unsuccessful, by enucleation. Copper, glass, and other foreign bodies in the retina cannot be well removed or even found by instruments without too much damage to the globe. These cases should either be subjected to immediate enucleation, or watched and at the beginning of inflammation the eye must be removed.—(H. V. W.)

Retina, Glioma of the. RETINAL NEUREPITHELIOMA. NEUROBLASTOMA (MALLORY). See **Glioma of the retina,** p. 5582, Vol. VII of this *Encyclopedia.*

In additions to the discussion of the subject there carried on the following is of practical importance.

F. Deutschmann (*Zeitschr. f. Augenheilk.*, 28, 1912), has claimed that glioma of the retina is derived from the cells of the retinal pigment layer. This opinion is controverted by Reis (*Zeitschr. f. Augenheilk.*, March-April, 1915), who believes that there is no evidence for Deutschmann's view, and says that it is at variance with all that we know about the genesis of this form of tumor.

He points out that a tumor grows from its own cells and not from those of adjacent tissues.

Glioma develops from the ever present embryonic cells, and is really present at an early stage in the development of the eye.

C. C. Hugger and Jonathan Forman (*Br. Jour. Ophthal.*, April, 1918) report a case of so-called glioma of the retina with an account of the pathologic findings in the study of the specimen. They prefer to call the tumor neuroblastoma and explain that it is a group term, used by Mallory for those tumors composed of cells which tend to differentiate into nerve cells. He describes (*Principles of Pathologic Histology*, 1914, p. 359) the variety of this tumor found in the eye as follows: "It is always congenital and often bilateral. It destroys the eyeball and may invade the brain. When the tumor grows slowly its structure can readily be made out. It forms small, gland-like cavities lined by cells which produce more or less perfect rods and cones. These structures project through a limiting membrane just as in normal retina. From the other end of each cell projects an axis-cylinder process. When the cells proliferate rapidly the gland-like cavities cease to be formed although the axis-cylinder processes may still be. With more rapid growth, cell differentiation ceases and the tumor passes into that ill-defined group, the so-called small, round-cell sarcoma. Owing to necrosis and absorption, a perithelial arrangement of the tumor cells around the blood-vessels is frequent."

In the report most of the important clinical and pathologic features

of tumors of this type are illustrated. After having consulted several physicians about a swelling of the eye of her two-year-old child, the mother brought the child to the Park Street Dispensary. The vitreous cavity of this two-year-old child was found to contain a distinct mass and a diagnosis of glioma of the retina was made. Removal of the eye was advised but the parents refused. Three months later the child was returned. The bulging of the eye was decidedly more noticeable. The vision was gone and it was impossible to see into the vitreous cavity. Enucleation was again advised but refused.

The condition continued to grow steadily worse until at the end of four weeks the parents begged for an enucleation to be performed. The entire contents of the orbit were eviscerated. In about ten days a paralysis of the lower extremities occurred. This progressed and extended over the entire body. In about one month from the time of the operation the child died. An autopsy was not granted.

The pathologic report showed that the eye was spherical, with a diameter of 2.5 cm.

Upon section the cornea measured 4 mm. in thickness and was regular in contour. From its attachment to about its middle, the iris was in intimate apposition with the posterior surface of the cornea. The lens occupied its normal position and was not the seat of apparent pathologic process. The vitreous cavity presented along its wall four whitish nodules. The largest of these nodules was situated just to the side of the entrance of the optic nerve and measured 1x0.7 cm. The greater part of the remaining portion of the cavity was filled with a reddish-gray mass.

Microscopic examination revealed the nodules to be portions of an infiltrating tumor. So completely did this tumor line the vitreous cavity that it was not possible to identify the retina at all.

The cells of the tumor varied in shape from large elongated cells to small round ones. In the more differentiated areas the elongated cells contained a nucleus rich in chromatin and placed at the one end. Rarely there was an apparent attempt to form gland-like cavities. In the largest tumor mass near the entrance of the optic nerve, a rather extensive degeneration had occurred among the tumor cells. Only those cells remained which were near a blood-vessel. In the border of this mass, mitotic figures were abundant. In the adjacent masses, there was little degeneration. The cells were closely packed and were small and round with a nucleus very rich in chromatin. The stroma was scant and the blood-vessels few. In the posterior portion of the eye the tumor cells had invaded the choroid and sclera. Using these tissues as a framework they had grown on through, and a few of the

tumor cells appeared on the outer surface of the sclera.

On the left side the smallest mass extended to and infiltrated the ciliary body. The small flat nodule on the right side extended along the wall of the cavity and becoming progressively thinner was lost at the equator.

The material filling the greater part of the remaining portion of the vitreous cavity was an old hemorrhage. It was composed of fibrin, pigment, and calcified plaques. This mass was intimately attached to the tumor mass on the right side by a zone of granulation tissue so that in the process of preparation a line of cleavage had been established in the tumor mass on that side.

To summarize: the position of the tumor, the age of the patient, the clinical course of the tumor would suggest a neuroblastoma of the retina. The tumor had grown so rapidly that in many areas it consisted of masses of closely-packed, small round cells, making the recognition of the type of the tumor impossible at these points. In the more differentiated areas, however, the tendency to develop tubule-like formations lined by elongated cells which repeat more or less closely the structure of the retina and the production of the axis cylinder processes in the cells of these areas, even where the gland-like structures were not formed, warranted the diagnosis of a neuroblastoma of the retina.

Paul D. Berrisford (*Roy. Lond. Oph. Hosp. Rep.*, March, 1916) reports (see abstract by R. H. Elliott in the *Br. Journ. of Ophthal.*, p. 109, 1917), that during the last 42 years the ratio of glioma retinæ to other diseases at the Royal London Ophthalmic Hospital has been slightly more than 0.01 per cent. The 41 cases under review support the opinion that glioma retinæ occurs more often in males than in females (males=22, females=17, sex not recorded in 2). The proportion of bilateral to unilateral cases was 1 to 7, which is below the usual figure. The tumor was observed at birth in 3 cases; within the first year in 9 cases; during the second year in 6 cases; during the third year in 3; during the fourth year in 4; during the fifth year in 3; and during the sixth year in 2. Nine cases out of the 41 may be considered as cured, 3 years having elapsed since enucleation. The importance of cutting the nerve far back is emphasized by the fact that in not one of the 9 recoveries had the growth invaded the optic nerve as far as its cut end. In one of the cases the glioma occurred in a shrunken eye; previous literature contains only 20 such cases. There are 2 previous instances only in literature where a child once affected with glioma has grown up and has had children who

developed the same disease; the present series adds a third case of the kind.

J. Meller (*The American Journal of Ophthalmology,* July, 1915), reports a case of retinal glioma which in five years has not only not progressed, but, on the contrary, has undoubtedly retrogressed. The patient, a four-year-old boy, was first seen on July 20, 1910. The history was that since birth the right eye had shown a divergence and had had a peculiar appearance. The parents were of the opinion that the eye had always been blind. During the past few months the parents had noticed a yellow, shining appearance in the pupil. The boy was well developed and lively. The right eye had normal motility, but was in a decidedly divergent position. The anterior part of the globe was normal, but with oblique illumination an intensely yellow reflex was seen to come from the detached retina which lay close to the posterior lens capsule. In this yellow mass numerous blood vessels were seen. The diagnosis of glioma could not be doubted.

Ophthalmoscopic examination of the left eye showed three circumscribed tumor nodules. These nodules had a yellow reflex and contained large, tortuous blood vessels. The largest of these nodules was situated in and down from the papilla and was several disc diameters in diameter. It protruded far into the vitreous. The vessels going downward from the papilla were very thick and tortuous.

In spite of the certainty of the diagnosis the parents refused to have both eyes removed. Roentgen rays were used on the eyes on July 26th and 27th. Potassium iodid was given internally and a bathing cure used. On September 5, 1910, the child was brought back with severe pain and increased tension in the right eye. This was enucleated.

The child was seen again on June 28, 1911, and the condition of the left eye was unchanged. In December, 1911, the boy was again examined, and it was thought that the tumor had increased somewhat in size. No change was noted in 1912. The child then disappeared until March, 1915, when he came back a strong boy. The focuses persist in the retina in the same form and diameter as on the last examination, but are flattened and have very much the appearance of atrophic choroiditic foci. They differ from this, however, in consisting of crumbly, chalk-like white masses. The histologic findings in the enucleated eye show a typical glioma exophytum. Otherwise the eye shows the usual signs of secondary glaucoma in a tumor eye.

The uniform and simultaneous retrogression of the tumor formation in all three nodules in the left eye is a point which merits attention. One nodule might by circulatory disturbances become necrosed and

result in the destruction of all tumor cells, but this could hardly explain the simultaneous changes of the same degree in all these nodules. The author says that only a simultaneously acting agent, perhaps present in the blood, could be sufficient to produce such alterations.

The clinical picture of glioma may be produced by products of inflammatory processes, but this cannot be considered in the present case. The ophthalmoscopic picture of glioma is so characteristic, the writer thinks, as not to be confounded with other affections.

Meller remarks that we surely are not foolish enough to speak of a *cure* of this glioma, because we cannot know whether living tumor cells are not left behind which suddenly may begin a rapid growth again.

Cases of retrogression of a glioma have been reported before, but this retrogression has always been accompanied by a shrinking of the globe, except in the case recently reported by Axenfeld. This case was given intense irradiation with Roentgen rays, and Meller remarks that the two irradiations in his case might be the cause of the retrogression.

von Hippel (*Am. Journ. Ophthalm.*, August, 1918) tried the effect of Roentgen radiation in a case of glioma of the retina. The patient was a child of sixteen months. The right eye had been enucleated for advanced glioma. The left eye, examined under narcosis, showed a fairly extensive tumor development. For a few weeks treatment was attempted with injections of tumor serum. An extensive retinal detachment was then found to be present. During the first few months of treatment with the X-ray there was apparently a slowly progressive improvement in the condition of the eye, but this gave place to a rapid increase in the tumor growth, which led to enucleation. Fifty-three radiations in all were given, the treatment being forced on account of the unfavorable development of the case.

An interesting and practical account of three cases of glioma treated by radium is given by Rex Duncan (*Am. Journ. of Ophthal.*, p. 715, Oct., 1918).

Retina, Granuloma of the. An example of this rare tumor is reported by Bishop Harman (*Oph. Review*, p. 128, 1911).

A lad, æt. 18, suffered a febrile attack with otorrhea in 1908. The left fundus showed what appeared to be an enormous red disc surrounded by a ring of swollen nerve fibres. The other eye was normal. Two years later the eye was blind, glaucomatous, and there was detached retina; it was excised. On section there was found an oval yellow mass (4 mm. by 2.5 mm.) in the stalk of the detached retina close to the papilla; the growth was purely retinal and consisted of densely crowded cells with very little stroma; there were signs of old

iritis. Determination of the nature of the growth was difficult, a diagnosis of inflammatory granuloma carried the fewest objections.

Retina, Gyrate atrophy of the. See p. 2139, Vol. III of this *Encyclopedia.*

Retina, Haab's disease of the. See **Retina, Injuries of the.**

Retina, Hemorrhages into the. See p. 5800, Vol. VIII of this *Encyclopedia;* also **Retina, Apoplexy of the,** as well as **Retina, Injuries of the.**

Retina, Hole in the. See **Retina, Injuries of the**; but especially, also, **Hole at the macula,** p. 5971, Vol. VIII of this *Encyclopedia.*

For a complete account of this subject see the illustrated description of a case by C. A. Burkholder (*Am. Journ. of Ophthalm.,* p. 81. Feb., 1918).

Retina, Hyperemia of the. This condition may be either *active* or *passive.* It is usually a sign of some optic, retinal or choroidal affection; it is not infrequently, also, evidence of a more distant disease. When due to refractive errors, saline laxatives, cold water douches, atropine-rest and tinted, correcting lenses soon bring relief. Other forms of the disease should be treated in view of the cause that produces them.

Retina, Hyperesthesia of the. Irritable retina. This term is applied to a condition in which, without demonstrable ophthalmoscopic lesions, the retina is unduly sensitive to light. Photophobia, neuralgia, blepharospasm, lachrymation, and inability to use the eyes for moderate periods are prominent symptoms. In pronounced cases there is pain in the temples or over the brow; quivering and unsteadiness in vision may be noticed; nausea and dizziness may be present; and, in short, the condition simulates asthenopia from an error of refraction. Yet these symptoms sometimes occur in eyes with normal refraction (Loring). Ophthalmoscopic examination may show veiling of the optic disc, particularly on its nasal side; slight redness of the nerve-head; a striate condition of the retinal fibres passing from the disc; and the whole fundus may appear indistinct. The choroid may present evidences of hyperemia.

Hyperesthesia of the retina may be a forerunner of serious organic optic-nerve disease (Loring). Errors of refraction or of muscle-balance and disease of the nasopharynx are causes.

The diagnosis of retinal hyperesthesia must be determined by exclusion. The prognosis should be guarded. While the affection does not lead to blindness, the inability to use the eyes may continue for a long period in spite of careful treatment. In the treatment the surgeon should investigate the general condition of the patient most thoroughly. The blood and urine should be examined. The condition

of the nose, throat, lungs, etc., as well as the state of the refraction and muscle-balance should be determined. Any departure from the normal should be corrected. Tonics, alteratives, and strychnia may be of benefit in some cases, while others may respond to electricity. Rest, change of scene and of occupation should be considered in intractable cases.—(J. M. B.)

Retina in glaucoma. In many of the acute, and in most of the chronic, forms of glaucoma atrophic and other changes occur in the retinal tissues. Hemorrhages into the retinal substance and alterations in the calibre of the central vessels are often noticed. See p. 5412, Vol. VII of this *Encyclopedia.*

Retina, Inflammation of the. See **Retinitis.**

Retina, Injuries of the. Wounds of the retina, like those of the choroid, can occur only after the ocular envelopes have been opened. The wound may be through the anterior portion of the eye, in which case the cornea and lens, or cornea, iris and lens, zonule or sclera and ciliary body must first be pentrated; or through the conjunctiva, sclera and choroid; or rarely through the orbit, Tenon's capsule, sclera and choroid. Then, too, objects may penetrate through one wall of the eye, pass through the vitreous and wound the retina, either piercing it and the sclera, thus making a double perforation to the orbit, or, as is the case with some foreign bodies, rebounding into the vitreous, even traversing this structure again and lodging in some other part of the retina. See **Retina, Foreign bodies in the.**

Wounds passing first through the sclera and choroid to the retina cause a more or less pronounced local hemorrhage, which spreads later into the parenchyma of the retina and into the vitreous. About this we find a circumscribed edema which tends to acquire a yellowish tinge from the formation of small blood infiltrates into the retinal tissue. If the retina be torn its edges roll up and float in the vitreous; if the choroid be rent at the same time the white sclera will be visible. This occurs in double perforations of the eyeball by foreign bodies.

The diagnosis is not possible unless we know by the depth of the scleral wound that the retina is directly cut through; or unless we see it later (by ophthalmoscopy) after the accompanying intraocular hemorrhage has cleared up.

The prognosis in small wounds is good, though healing occurs with a scotoma of the visual field. When the macular region is injured the loss of sight is great and leads to atrophy of the nerve with central scotoma.

The therapy is that of all penetrating wounds of the eyeball.

Prolapse of the retina occurs in very large wounds and ruptures of

the sclera and is attended with considerable loss of vitreous. A portion or all of the retina appears in the wound and extrudes from the eyeball. The sight is destroyed, but in favorable cases the form of the eyeball may be preserved by scleral stitches. Atrophy of the globe or infection with acute panophthalmitis follows.

The retina may be dislocated in cases of luxation of the lens with ruptures of the zonula, and appear in the anterior chamber.

Concussion of the retina. This form of injury of the retina, which is often observed after external violence to the eye by blunt objects, is undoubtedly one of the conditions to which has been given the name *commotio retinæ*, as an analogue to commotio cerebri. Other conditions in which a molecular degeneration of the retina, after blows, was supposed to have taken place, are probably hemorrhage into the sheaths and ischemia following injury to the nerve behind the globe, to which the term of *commotio retinæ* was likewise applied until in more recent years their cause has been explained.

This form of retinal edema is caused by a compression of the globe, from blows, thrown or flying foreign bodies, or from gunshot injuries.

The mechanism is the same as that of rupture of the choroid, but the force is not so great, or perhaps the globe is not so indented in direct cases.

Berlin's opacity. Berlin described the contusion as due to a bloody exudate between the choroid and sclera, from which the serum infiltrates the retina, but this does not seem to explain their rather quick disappearance and the slight loss of normal acuity therefrom. It is well to think that the condition is one of anemia due to reflex contraction of the blood vessels at the contused area. A transient form may be the same as exists in many persons who have been temporarily blinded by a blow upon the eye. The real nature, however, of this condition, is not yet known.

There is a milk-white evanescent opacity at the region of the injury, and a curved, semi-lunar or almost circular opacity at the macula around the fovea, which sometimes shows as an isolated, more or less pale, spot, distinctly separated from the remainder of the macular opacity. This is probably not caused by an opacity, as the membrane is exceedingly thin at this point; it is probable that its substratum is situated behind the floor of the central fovea; perhaps in the pigmentary epithelium, perhaps between the latter and the layer of rods and cones. The opacity at the place of impact is more extensive, marked and persistent than that at the macula. The retinal vessels pass over the area undisturbed and the retina is not elevated. With Berlin's opacity there are often other signs of contusion of the globe,

as spastic miosis or mydriasis, cramp of accommodation, myopia and myopic (lens) astigmia, bleeding into the ciliary muscle and permanent changes in the macula.

The light sense is generally reduced but soon returns; in fact, the visual power is usually intact, although in some cases central vision may be temporarily lowered without a proportional decrease in the periphery of the field. Contraction of the field also occurs.

The complications are irido-dialysis and other forms of iris rupture, when the blow comes from the front; rupture of the choroid, retinal hemorrhages, as well as rupture and dislocation. In severe injuries hemorrhage into the nerve sheath and fracture of the canalis opticus, with optic nerve atrophy, have followed.

The opacity commences immediately after the trauma, in some cases taking one or two days to fully develop, reaching its height in 24 to 36 hours after extending over the greater part of the fundus, passing away in three or four, or at the latest, eight days without leaving any traces. When vision is reduced other injuries to the macula, retina or nerve must have occurred.

The condition, no doubt, has often been mistaken for separation of the retina, but should be readily distinguished, for it is milk-white, the course of the vessels is not affected, there is no parallactic displacement, there is no marked degree of hyperopia, but frequently myopia, and no retinal folds. In dislocation of the retina the retina is translucent and more of a grayish-green from subjacent fluid, and the course of the vessels is uninterrupted. There is marked hyperopia, folds and (usually) tremulousness of the detachment.

In embolism the edema exists but is not as white and the vessels are not as contracted (as the arteries carry little blood) while the veins may be tortuous and full. In retrobulbar hemorrhage, with contracted blood vessels and a gray fundus, the appearances are quite like those of Berlin's opacity, but they occupy the entire fundus and there is usually exophthalmus from the pressure of the intraorbital hematoma. In Berlin's opacity the vision is but seldom even temporarily affected and the visual field remains normal.

Traumatic edema at the macula always progresses to full recovery within a few days unless complications occur, especially at the macula.

Traumatic excavation of the macula. "Holes" in the macula are observed in cases of injury to the globe as the result of retained foreign bodies or as a sequel of *commotio retinæ*. The hole appears punched out, with perfectly round, sharp edges, and, what is very striking, reveals in the depths an area of choroiditis with atrophy and pigment proliferation corresponding to the retinal lesion.

In some cases microscopic examination of the specimen shows that an actual hole does exist, the hole corresponding to an area of retinal atrophy enclosing a cystic space filled with fluid.

Macular holes are produced, as Coats showed, by an edema of the retina at the posterior pole. The edema may not be confined to the region of the fovea, but the appearance of a hole will only be produced if there is a defect at least of the inner layers of the retina. A total defect of all the layers of the retina, without membranes or shreds, is necessary for the completely typical picture; and that such a complete defect may arise from retinal edema is proved by his case. The edema may result from a contusion, in which case it is the same as the edema that produces Berlin's opacity; or it may arise from toxins in the vitreous, the result of iridocyclitis; or from retinal vascular disease. See **Hole at the macula,** p. 5971, Vol. VIII of this *Encyclopedia.*

Haab, out of 167 cases of contusion of the eye where it was possible to examine the fundus, found 82.6 per cent. without any changes, 4.7 per cent. Berlin's opacity only at the macula and 12.5 per cent. opacity at both the macula and periphery of the retina. In 16 the vision remained practically normal, in one 6/xxiv and in one 6/lx in amount of opacities of the media. Five had pigmentary degeneration at the macula, discovered from the first to the ninteenth day, and in these the outcome was not so good. In one there was atrophy of the optic nerve and in one choroidal changes.

The treatment is protection of the eyes from light by coquilles, medium dark room, atropin and bandage, if ciliary spasm occurs. See, also, p. 2517, Vol. IV of this *Encyclopedia.*

Haab's traumatic macular disease. Haab in 1888 described a form of traumatic macular disease after severe contusions of the eye.

Severe external violence from a blunt body, as a blow from a fist, hammer, stone, arrow, whip, wadding from a cartridge, etc., of greater intensity than that which produces Berlin's opacity, causes permanent degenerative changes at the macula which have been called Haab's disease of the retina and macula lutea.

The cases may begin with Berlin's opacity, in which the visual acuity is more affected than would be expected and does not return to normal after 10 to 12 days, or the disease may not manifest itself clearly until several weeks have elapsed.

In 192 cases of severe contusion injury to the eye in which ophthalmoscopic examinations were made 23.96 per cent. showed macular disease. The percentage must be much greater, for in many injuries to the eye the fundus is never examined.

Some of the cases previously put down as malingerers have a real affection of the organ of vision demonstrable by the ophthalmoscope.

At first the macula is reddish and the fovea may be occupied by a still redder spot, with very fine stippling or a minute hemorrhage. The reflexes of the fovea are not found.

Later the macular area may become more mottled and the pigmentation a little stronger about the macular region, or the mottling and pigmentation may be very insignificant, especially in the beginning, and be replaced by distinct pale patches. As a rule the disease does not manifest itself clearly until several weeks have passed, but the appearances are to be seen for years afterwards. The central vision is markedly and slowly diminished, forming at first a relative, then a total, central scotoma, while the peripheric field is little or not at all affected.

The examination of the macula after contusions is often difficult, as there may be great photophobia and the lids may be much swollen. Likewise there may be a wound of the conjunctiva, cornea or sclera, erosions and opacification of the cornea and lens, bleeding into the anterior chamber and vitreous, rendering the media turbid or opaque. However, all eyes that have been subjected to contusion should be carefully examined by the ophthalmoscope at the earliest possible moment, and at intervals for several weeks thereafter, especially if the patient complains of lowered vision after the accident; and no one should be declared a malingerer until we are sure there has been no resultant macular disease.

The prognosis is bad. Central vision deteriorates for months, but the process may come to a halt before a large central scotoma forms.

The therapy is that of ocular contusion in general—atropin, rest, and protective glasses.

Hemorrhage into the retina, and of the retinal vessels. In perforating wounds the vessels of the retina may be cut, and with those of the choroid cause hemorrhage into the vitreous. Direct contusions from foreign bodies may also occur.

Obstetric injuries account for many cases of interrupted binocular vision from retinal hemorrhages.

The force of contusions of all sorts on the eye or head may be communicated indirectly to diseased vessels, particularly to those in arteriosclerotics and in the hemorrhagic diathesis, and cause them to rupture. An indenting blow upon the eye may rupture the retinal vessels without bursting the globe.

Except in severe contusions or wounds the patient seldom complains of loss of vision if the bleeding into the vitreous is not in the

visual axis, although he may see a dark spot before the eye. The ophthalmoscope generally shows a single hemorrhage proceeding from an artery, or it may be in the vein after direct contusions. If the bleeding be great only an extra-vitreous hemorrhage may be diagnosed. Fresh blood-clots look cherry-red; older ones blackish. The blood stain may diffuse throughout the vitreous, but as a rule it is circumscribed, showing as a streak or projection. Commonly, when within the retina, or pre-retinal (between the retina and the vitreous lamella) the upper margin of the clot is horizontal.

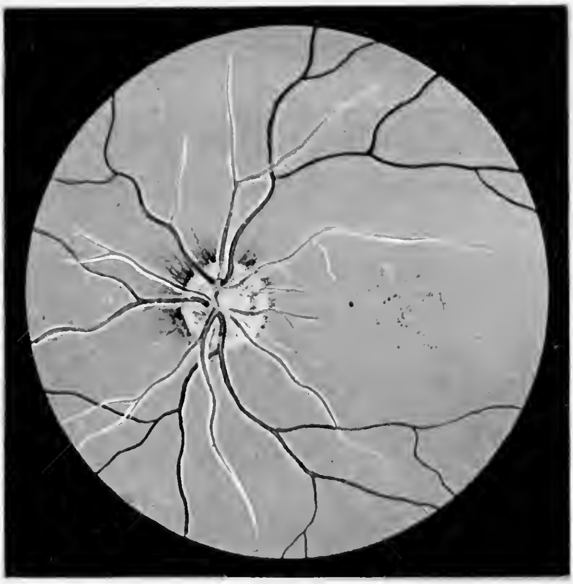
A hemorrhage may be fully resorbed in one or two months (longer in old subjects) or it may become organized and persist indefinitely as a membrane in the vitreous or in the retina, as a yellowish, pigmented area in which the retinal elements will atrophy. A scotoma naturally follows and when the bleeding has been great, permanent loss of sight results from the secondary changes. Macular bleeding cuts off central vision.

Therapy consists of pressure-bandage, rest, administration of calcium chloride, ergot, pilocarpin sweats, and mild cathodal galvanism.

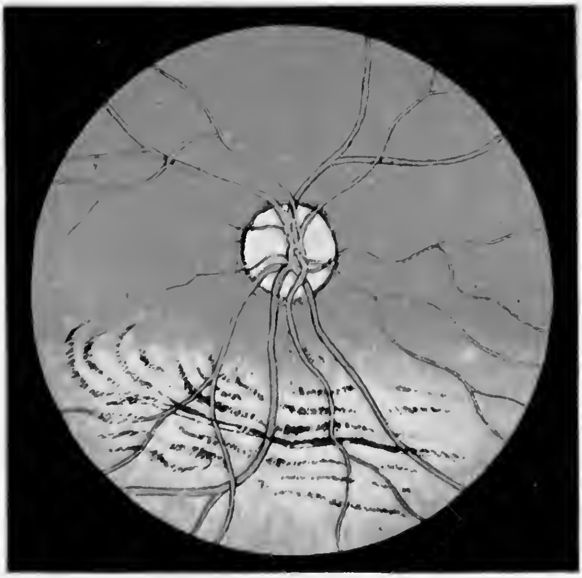
Rarely a *new formation of blood vessels* may occur in the retina after injury, as first described by Galezowski in a near-sighted and weak woman who had been struck upon the eye by a key and 14 days later was nearly blind. In the periphery of the inner half of the retina there was a tear with serous infiltration and tortuous vessels. Later on there developed in this place an aneurism, from the arterial twig, of the size of a pin head.

Isolated ruptures of the retina are seldom seen except when the eye itself is torn open, as in scleral rupture. In other cases they may occur together with that of the choroid. The vessels are broken and torn and the wound edges of the retinal laceration are rolled inwards. Haab states that it is not uncommon to find in retinal detachment a tear or hole of varying size and shape, often surrounded by a shred of membrane of a corresponding outline, which appears to have been torn out and floats in the vitreous. Moderate blood streaking is often observed in the vitreous. The choroidal vessels show more plainly through the opening than through the attached retina; often a tongue of retina is seen in the opening. Small tears are of no immediate moment, although the retina usually further detaches, as it always does where the laceration is of any extent. When the rupture is at the ora serrata it is practically a dialysis and leads to further detachment.

Rupture of the retina accompanying rupture of the choroid. With rupture of the choroid the retina may also tear, usually in line with



Atrophy of the optic nerve and retina following optic neuritis. (Würdemann.)



Healed detachment of retina. Striated retinitis. (Würdemann.)

that of the choroid, either through direct force of the contusion or, secondarily, from the pressure of sub-retinal hemorrhage—the blood seeking a passage into the vitreous. In such combined ruptures the visual function is lost immediately, except in favorable cases.

Traumatic detachment of the retina. Myopic eyes, in which the vitreous does not completely fill the globe, are especially predisposed to retinal detachment from injury.

In those cases where the detachment may be actually traced to a trauma it may have been from a poke in the eye, a blow, a thrown object, or an opening of the ocular envelopes by a wound with resultant cicatricial changes in the vitreous.

In traumatic detachment five causes are to be differentiated: 1. Inflammatory retraction of the vitreous with adhesion to the retina. 2. Retinal tears. 3. Post-retinal hemorrhages. 4. Cicatricial contraction of a scleral wound. 5. Sudden collapse of the eyeball, with addition of trauma. Only in the first group does the vitreous play an active rôle. When adhesions are absent there is detachment of the vitreous. The retina simply lies upon the choroid without being connected with it anywhere except at the papilla and the ora serrata, being kept pressed against the choroid by the vitreous. A detachment is possible only when either the pressure exerted by the vitreous ceases to act, or when the retina is pushed away from its bed by a force greater than this pressure.

Injuries or operations in which a large quantity of vitreous is lost, with shrinking of vitreous in consequence of exudative organization and contraction, especially after irido-cyclitis and iridochoroiditis, favor the condition.

Detachment of the retina, in an unopened eye, through direct trauma, is of rare occurrence except as a secondary result of contraction of exudation from the choroid.

It is most common in men between the ages of 44 and 60.

In traumatic cases the ophthalmoscopic view may be at first obscured by opacities of the media, such as hemorrhages into the anterior chamber and vitreous. Externally the eye looks normal, but the anterior chamber is often strikingly deep and the tension is diminished. The ophthalmoscope shows, in a pronounced case, a delicate grayish membrane back of the pupil projecting into the vitreous, rising above the level of the fundus and, being focused with a convex lens, varying according to the projection, upwards to ten, or more, diopters. Over this the retinal vessels are seen to course, interrupted as they dip into the folds of the membrane, and are lost to view. If the sub-retinal fluid be serous, a slightly greenish color is seen; if the fluid be blood

or tinged with blood the color is dark-gray or reddish.

The detachment may develop at any spot, but usually changes to the lower part of the fundus on account of the effect of gravity on the subjacent retinal fluid. In traumatic cases there is a greater tendency to be reapplied to the choroidal surface than in myopia, and hence cure of such cases may be expected by proper treatment.

The subjective symptoms consist in the disturbance of vision, especially a limitation of the field, usually upwards, the detachment being below. In the beginning of a detachment there is often dazzling and metamorphopsia. This is perceived by the patient as a dark cloud corresponding to the portion detached. The patient complains of a dark curtain which veils him from the upper part of objects, as, for instance, he may see the body but not the head of a man standing in front of him. Hence the examination of the visual field is of great importance in the diagnosis. In total detachment the blindness is absolute.

The grayish, floating membrane in the vitreous, projecting anteriorly and in focusing which the retinal vessels are seen to course, is pathognomonic. The visual field is contracted, corresponding to the portion of the retina detached. The tension is diminished and the anterior chamber usually deeper than normal. Differential diagnosis must be made from Berlin's opacity, in which the level of the retina is normal and the vessels uninterrupted, and especially as regards choroidal sarcoma. In many cases of the latter the diagnosis has not been made until too late to prevent metastasis by enucleation, the cases having been diagnosed as simple retinal detachment. Such an error of observation is nowadays inexcusible.

In the traumatic and myopic forms the portion detached, when viewed with the ophthalmoscope, generally appear as a grayish, mobile surface, composed of folds, creases and undulations. Over all run the sinuous retinal vessels, arteries and veins, both showing darker than normal, and with no sign of the underlying choroid visible. In detachment secondary to tumor—which is nearly always a sarcoma—the retina over it is smoother, i. e., not thrown into folds; the limits of the retinal separation are more sharply defined; the whole is but slightly movable, or not at all; the retinal vessels, save at the borders of the detachment, are much less tortuous. In short, its aspect is dome-like—more or less rigid. Unfortunately, these characteristics are by no means constant, but merge into each other in the two forms. The surface of the detachment must be studied minutely, with dilated pupil and very strong illumination, preferably by the direct method. By using a concave mirror held very close to the eye, and turning on

various convex lenses, one can examine not only the surface, but can, in a measure, look into the detachment, as it were. In this way one often obtains evidence of a neoplasm. See **Retina, Detachment of the.**

When a detachment is situated between the equator of the globe and the ciliary body, and the signs just mentioned are not positive, the transilluminator may render great service. Another sign of great value, when present, is a bloody infiltration behind the detached retina, evincing a tumor. Minor signs are those, for instance, of location. A tumor is to be suspected when a circumscribed detachment appears at the vault of the vitreous chamber, or in the macular region. Detachment with hypertension, be it ever so slight, is suggestive of a tumor. So is slowly progressive failure of vision, instead of sudden or rapid; as also the persistence of good or fair vision with a rather extended detachment. Close study of the field of vision may furnish a clue. The limits of the scotoma in simple detachment are less precise than are those of the secondary variety. The examiner should remember that, in rare instances, the tumor is found diametrically opposite the point where the detachment is located. Hence the importance of close scrutiny of the entire fundus.

Traumatic detachment of the retina is more apt to be cured either spontaneously, medicinally or by operation than are the idiopathic types. It is less apt to spread and one may always hope for healing. The smaller the detachment and the more recent the case the more encouraging the prospect. The successful cases, also, are those that present a clear vitreous and a bagging of the detached retina.

When a laceration of the retina also occurs a permanent visual (field) defect remains, and when the retina is completely detached cataract, optic nerve atrophy and atrophia bulbi complete the clinical picture.

For *therapy* of this accident see **Retina Detachment of the.**

Striæ retinæ following traumatic retinal detachment. Fuchs claims that a true spontaneous reattachment of the retina does not occur. Even though a functional cure result, a portion of the retina seems so greatly damaged as to have but little functional power, and the defect can readily be made out by the ophthalmoscope; the fundus in the injured region is spotted, and frequently traversed by restilinear striæ, either pure white or lined with pigment. These lie in front, back of, and along the retinal vessels, being formed by strands of connective tissue from organization of the sero-fibrinous, sub-retinal exudate, and forming a *retinitis striata.* The whole affected area is separated from the remaining normal fundus by a sharp, usually

curved line, yellowish or gray and surrounded by pigment.

Perivascular striæ occur along the vessels from perivascularitis, and have no particular relation to trauma. Such striations may, however, follow an incised wound of the sclero-choroid and retina, as shown in a case where an oculistic quack, who "cured" everything from diabetes to diarrhea. In doing a "graduated" tenotomy, he cut through the sclera, choroid and retina with his scissors, producing a most picturesque condition of the fundus, as seen about a year later. A large, spear-shaped, white cicatrix existed, temporally from the fovea, deeply pigmented at its edges, with convergent retinal striæ and other pigment changes from a striate retinitis, with perivascular striæ, Haab's macular disease and optic nerve atrophy. Indeed the condition well represented all three forms of retinal striation.

Retrovascular striæ are due to organization of the sub-retinal exudate. Many such cases have been reported. See, also, **Angioid streaks**; also **Retinitis striata.**

Dazzling or glare of the retina has been quite fully treated under **Eclipse amblyopia**, p. 4127, Vol. VI, and **Dazzling**, p. 3778, Vol. V of this *Encyclopedia.* It is a combination of photo-chemic and heat injury, mostly due to the effect of the ultra-violet rays. Haab points out that in all cases of direct gazing at the sun there is danger of a scotoma being permanently made, more or less as large as the size of the sun picture in the retina, the point of fixation; the permanent damage being little less than at first. The macula lutea has the most delicate anatomical structure of any tissue of the eye and is specially vulnerable. It is likewise affected by strong commercial electric lights. We must not confound this condition with that of so called snow-blindness which is due to irritation of the conjunctiva and cornea.

Injuries to the retina from firearms. Besides the wounds produced by shot, portions of bullets or grains of powder, etc., passing through the coats of the eyeball and thus injuring the retina, especially described under **Military surgery of the eye,** this delicate membrane may likewise be greatly injured by contusion and concussion, either from the results of the projectile or from the concussion of the air due to the explosion.

The most common condition of the retina produced by firearms, aside from those first mentioned, are edema, hemorrhage, rupture, and detachment.

Commotio retinæ or Berlin's opacity occurs from direct shots, spent or glancing balls and in indirect lesions where the ball enters the orbit or its neighborhood.

Hemorrhage into and under the retina often arises from contused

shot injuries of the globe, presenting a similar picture to that of retinal hemorrhages caused by other contusions. If it affect the macula there will be a central scotoma. Bleeding under the retina also occurs.

Rupture of the retina is found in connection with that of the sclera and choroid. In only a few cases has it been seen alone, and in these from bullet wounds of the nerve when the latter has been torn out of the eyeball. Detachment of the retina is common after shot injuries. It is usually due to sub-retinal bleeding, or, in case of perforation, may follow loss of vitreous. Secondary detachment of the retina follows all forms of degenerative processes in the vitreous.—(H. V. W.)

Rupture of the central artery in the stem of the optic nerve is reported by C. Velhagen (*Klin. Monatsbl. f. Augenheilk.*, 54, p. 676), who gives the clinical history of a woman, aged 26, suddenly blind in her right eye and presenting the typical aspect of embolism of the central artery. Death occurred after five weeks from Bright's disease. The autopsy and microscopic examination of the eye revealed as the cause of the sudden closure of the central retinal artery a rupture of its wall and a hematoma which had compressed the lumen of the vessel to such an extent that the picture of embolism of the central artery resulted. The thrombus of the central vein was secondary and must be considered due to vascular stasis. The hemorrhage was attributed to the chronic hemorrhagic nephritis. This theory was rendered more probable by the inflammatory changes of the central retinal artery within the lamina cribrosa and its retinal branches, such as are often found in albuminuric retinitis.

Isolated, *traumatic detachment of a retinal vessel* is reported by J. Gonin (*Annales d'Oculistique*. Vol. cxlvii., Jan., 1912; review by Souter, *Oph. Review*, p. 237, Aug., 1912). A boy of seven was struck on the left eye with a stone and three weeks later came complaining of defective sight in that eye, persisting unchanged from the day of the accident. Vision was reduced to hand-movements in the outer part of the field. He had left mydriasis and remains of lid ecchymosis. Ophthalmoscope showed a rupture of choroid encircling the papilla on all sides except the nasal; on the edges and at the end of this rupture were some pigment spots. The optic disc was pale, and retinal arteries and veins both appeared generally contracted. A blackish thread was seen floating in the vitreous like a persistent hyaloid artery, but its point of attachment was on the edge of the choroidal rupture instead of being on the papilla. Close examination showed that it was continuous with a retinal vessel, apparently a vein,

whose central portion for about a disc's diameter seemed to have disappeared, its course being merely suggested by a few reddish dots. The only interpretation, Gonin says, is that the filament floating in the vitreous is no other than the missing portion of the retinal vessel. The choroid rupture, which usually spares the retinal vessels, was accompanied this time by a rupture of a vessel at its emergence from the papilla, and also by a separation of the vessel from the retinal tissue for part of its length. The central portion, thus freed, projected into the vitreous. The filament showed many different aspects, owing to its movement in the vitreous, its direction, length, clearness, tint, thickness as well as form all being altered. Two sketches accompany the paper and demonstrate this variability. The detached portion appeared to be too long for the part that was wanting on the retina, but this was an ophthalmoscopic illusion. The extremity looked attenuated or rounded depending on whether the actual central end was focussed, or a rounded knuckle projecting forwards. During two weeks of observation the peripheral part of the torn vessel gradually effaced itself.

The case is the only one of its kind Gonin had observed, and in the literature he had found only one analogous to it, described by Dunn in 1896,—the case of a woman of 43 under treatment for exudative choroiditis, who, two years later, complained of muscæ volitantes, the inferior nasal artery was seen to be detached from the retina a disc's diameter from the papilla, and to have its peripheral end, not its central, projecting into the vitreous. The trauma explains the difference.

Retina in myopia. See **Myopia** rubrics, especially **Myopia, Progressive,** p. 8274, Vol. XI of this *Encyclopedia*.

Retina, Inverted. See **Retina perversa.**

Retina, Irritable. See **Retina, Hyperesthesia of the.**

Retina, Ischemia of the. The term ischemia of the retina indicates that the cause of the condition rests in or near the eyeball itself. Thus, ischemia follows plugging of the arteria centralis retinæ. It has been observed in spasm of the retinal arteries due to unknown causes; it also occurs in quinin-blindness.

Ischemia of the retina may be general or partial. In embolism of the central artery, where the plug is located in the main trunk, the whole fundus is white and bloodless except such portions as are supplied by a cilioretinal vessel. An example of partial ischemia is found in case the embolus successfully traverses the central vessel and lodges in one of its branches.

The diagnosis between anemia and ischemia of the retina can be

determined by taking into consideration the general condition of the patient and the opthalmoscopic appearances.

Ischemia of the retina due to spasm of the retinal arteries probably occurs oftener than has been supposed, and it serves to explain some obscure cases of transient blindness. The blindness may last for a few minutes or for several hours. Transient narrowing of the retinal arteries has been observed in epileptiform convulsions (Hughlings Jackson), in migraine, in the cold stage of malarial fever, and in quinin-blindness. Spasm of the retinal arteries has been studied opthalmoscopically by von Graefe, Knapp, Noyes, Lundie, Loring, Harbridge, Zentmayer, and others. It is possible that spasm of the retinal arteries is a precursor of actual blockage (embolism or thrombosis). The attack begins with a narrowing of the arteries, followed by a similar condition of the veins, ending in a complete collapse of some or all of the retinal vessels. The optic disc becomes pallid and the retina may be hazy. Often in these cases there is a cardiac lesion. The treatment includes the immediate use of amyl nitrite and, later, attention to the general health.—(J. M. B.)

Geo. Coats (*Ophth. Review*, p. 118, Apr. 1914) in reviewing the paper of Lottrup-Andersen (*Klin. Monatsbl. f. Augenh.*, Vol. LI, ii, p. 740, 1913) remarks that it has long been a moot point whether the yellow color of the fovea is a vital, or only a post-mortem, phenomenon. The sceptics will be satisfied only if it can be shown that the conditions which render the color visible in the dead, also render it visible in the living, eye; the requirement being that a sufficient quantity of light should be reflected from the retina itself to prevent the yellow tint from being swamped by the red color of the choroid. These conditions are more or less fulfilled in acute ischemia of the retina and in deep physiological pigmentation of the choroid; the attempt has also been made to investigate the question by using a light containing no red rays—the sodium flame, or the mercury vapor lamp. In none of these three cases has the presence of a yellow color been demonstrated beyond cavil, though Dimmer claims to have seen it by using strong daylight.

Lottrup-Andersen's case of obstruction of the central artery showed an unusual degree of opacity, the retina being almost chalky-white and considerably thickened. At the fovea there was a small, sharply-defined, dark, yellow-brown area, about 1/3 P.D. in diameter; outside this, occupying an area of about 2/3 of a P.D. the color was citron-yellow, fading off imperceptibly in the periphery. The color was visible with gas-light, the sodium flame, and the mercury vapor lamp.

The observation scarcely amounts to a final settlement of the ques-

tion. The sceptic might still inquire why this appearance is not more frequently seen in cases of obstruction of the central artery, and might also point out that the retina after obstruction, approximates to the dead retina not only in opacity, but also, as regards its inner layers, in deadness.

Retina, Juvenile diseases of the. In the juvenile eye the retinal affections of periphlebitis, exudative retinitis and angiomatosis are well known, and uveal complications are occasionally present. For example, they have been found in some 20 per cent. of cases of periphlebitis. Gilbert (*Bericht der Oph. Gesellschaft,* 1913; abstract in *Oph. Review,* p. 116, 1914) describes two severe cases of iridocyclitis as examples of juvenile vascular disease. The first eye was removed from a woman of 29, and the second from a young man apparently between 20 and 30. In both the pathological changes were almost entirely restricted to the anterior region of the uvea. In the first case marked thickening and hyaline degeneration of all the blood-vessels in the iris were the essential changes. The retinal veins showed meso- and periphlebitis, while the posterior part of the choroidea was normal. In the second case chronic inflammation and hyaline degeneration were present in the veins of the iris, and a round-celled exudation had compressed the central vein behind the lamina cribrosa with resulting hemorrhages in the retina and vitreous. In a third case numerous hemorrhages were found in the tissue of the papilla and beneath the retina, with blocking of the vessels behind the lamina cribrosa by phlebitis. The eye was taken from a girl of 17. It had been blind from atrophy for six years, and had then become glaucomatous.

In these three cases tuberculin reaction was positive, Wassermann's negative. Gilbert assigns the cases to the group of juvenile vascular diseases because of the phlebitic infiltration of the central vein and its branches, and the hyaline degeneration of the veins of the iris. The location of the principal lesion in the vein behind the lamina cribrosa is what chiefly distinguishes Gilbert's cases from the typical periphlebitis described in the retina.

In the discussion Straub (Amsterdam) held that the periphlebitis did not indicate any special lesion of the actual vessels, but merely demonstrated that the perivascular channels are the lymphatic vessels of the retina, such conditions being found in other diseases, e. g., in sympathetic ophthalmitis.

Fuchs also regarded the histological appearances as not uncommon. They are seen in septic endophthalmitis, and also in cases of deep corneal ulcers, being the result of entrance of toxines into the lymph stream.

Siegrist (Bern) classifies the cases of juvenile periphlebitis of the retina into those in which the main trunk is alone affected, and those in which the disease is restricted to the small branches at the periphery.

Gilbert in reply stated that his chief object in the communication was to show that in young people severe tubercular disease of the anterior uveal tract may occur as vasculitis affecting both the iris vessels and the central retinal vein.

Geo. Coats (*Oph. Review*. p. 284, Sept., 1914) in reviewing the article of B. Fleischer (*Klin. Monatsbl f. Augenheilk.*, 52, p. 769, 1914) notes the view of Axenfeld and Stock that many cases of vascular disease in young persons are due to tuberculosis. Their opinion, however, was founded chiefly on clinical and experimental considerations, and on the tuberculin reaction. Fleischer contributes a case which appears to prove their contention from the pathological standpoint.

The patient, a man aged 36, suffered from pulmonary phthisis and came to hospital complaining of diminution of vision of about one month's duration. In the left fundus periphlebitis of the retinal veins with hemorrhages, and some patches of old peripheral choroido-retinitis, were observed. No disease was present in the anterior parts of the eye. Under observation the retinal changes disappeared almost entirely. A year later, however, a nodular form of iritis appeared in the other eye, and ophthalmoscopic examination showed extensive retinal hemorrhages with widespread periphlebitis. This eye was subsequently excised for glaucoma.

Microscopical examination showed that the disease in the anterior part of the globe was indubitably tuberculous. In the vicinity of the retinal veins also typical groups of epithelioid and giant cells, in places showing slight necrosis, were present, forming nodules lying on one side of the vessel, or sheaths surrounding them. Tubercle bacilli could not be demonstrated. The vein lumen was narrowed by these nodules, and in places it was also constricted or occluded by endothelial proliferation. Inflammatory changes were confined to the vicinity of the vessels; the retina itself was free. Pre-retinal hemorrhages and retinitis proliferans were also observed.

In spite of the failure to find the characteristic bacillus the tuberculous nature of these lesions scarcely admits of doubt. The case proves therefore that hemorrhages of this type are due to actual tuberculous foci, and not, as recent opinion has tended to assume, to tuberculous toxines.

The case afforded a good opportunity of correlating certain fundus

changes with their pathological equivalents. White areas situated on the veins were due to groups of epithelioid cells and to serous infiltration, not to any change in the vein wall itself. On the other hand thickening of the wall of older standing accounted for the appearances in some situations where the vessels were converted into white lines. Certain white areas in the retina were due to fibrinous coagula among the fibres of Müller, others to varicose nerve fibres.

Was the infection conveyed by the blood, or did it spread backwards from the anterior part of the eye by way of the lymph paths? The localization in the perivascular sheaths of the veins seemed to point to this latter explanation, but against such an hypothesis must be set the universal distribution of the affection, the fact that no disease was present in the anterior parts of the other eye, and the consideration that if this be the correct interpretation retinal hemorrhages should be commoner in cases of tubercle of the iris. In spite of these seemingly weighty objections, the author leans to the hypothesis of transmission by lymph paths; but after all the question is of minor importance since in any case the primary intraocular infection must have been hematogenous.

The case differs in some particulars from others of a similar nature which have been recorded. In Gilbert's there was a pre-papillary tuberculous granuloma but no hemorrhages; in Stock's the hemorrhages were apparently due to injury of the endothelium by a toxin; and in Fehr's the vessel walls were much diseased, suggesting syphilis rather than tubercle.

Van Duse (*Trans. Belg. Oph. Soc.*, Apl. 28, 1912) discovered in a young woman of 24 opacities at the posterior pole of the lens, floating opacities in the vitreous, and the fundus had the aspect of a neuro-retinitis without prominence of the papilla. There was retinal periarteritis, recurring hemorrhages and small white spots at the right macula. Clinical examination excluded syphilis and tuberculosis. The probable cause, he tells us, was a pathological state of the internal secreting glands. See, also, **Periphlebitis retinalis**, p. 9610, Vol. XII of this *Encyclopedia;* as well as **Retina, Angiomatosis of the**.

Cords (*Zeitschr, f. Augenheilk.*, Nov.-Dec., 1911) reports two cases of uncomplicated retinal periphlebitis. The veins were irregular in calibre, tortuous in certain parts, with white sheaths, vessel tufts and anastomoses. White patches and retinal hemorrhages were seen adjoining the veins. Both eyes were affected in one case, which seemed to be of tubercular origin, and improved rapidly under tuberculin treatment. In the other case only the left eye showed these symp-

toms, and no marked improvement was obtained by absorbent remedies.

Cords collects fourteen cases of the kind; seven of unknown etiology, one of hereditary syphilis, and six probably due to tuberculosis. Igersheimer reports three cases in which a tuberculous origin seemed the most probable, two of the patients suffering from pulmonary tuberculosis. Harms reports a case in which both eyes were involved, the patient giving a positive tuberculin reaction and negative Wassermann. He also records a case of new formation of vessels in the retina.

Cords also reports three cases of recurrent retinal hemorrhage in patients of 15 to 29 years. Two gave evidence of tuberculosis. The ophthalmoscope showed lesions similar to those seen in his other cases of periphlebitis. In the case reported by Davis there was a distinct tuberculin reaction. Perivasculitis was a pronounced feature. The blood pressure and response to other blood tests seemed normal throughout. Hemorrhages persisted in spite of varied treatment. In Cunningham's case, a male aged 20 had retinal hemorrhages and exudation in both eyes. The veins were dilated and tortuous, with white lines along some in the periphery. The arteries were bright. A small star figure was found in one macula, but there was no albuminuria. Wassermann negative. Two cases are reported by Moissonnier occurring in males aged 18 and 28. The former had a buccal infection caused by bad teeth, and after their extraction the hemorrhages had not recurred. The other patient seemed benefited by antisyphilitic treatment.

Retina, Laceration of the. See **Retina, Injuries of the.**

Retinal anesthesia. See **Retina, Anesthesia of the.**

Retinal angiopathia traumatica. See p. 469, Vol. I of this *Encyclopedia.*

Retinal arteries, Anomalies of the. The frequent anomalies known as *cilioretinal arteries* are described on pp. 615, Vol. 1, and 2242, Vol. III of this *Encyclopedia.* In addition Walter Parker (*Am. Journ. of Ophthalm.*, p. 495, 1918) in the consecutive examination of 3554 eyes found 34.75 per cent. with cilio-retinal arteries; they were more often (20.2 per cent.) in the upper and lower temporal regions than in the macula (13.2 per cent.). In 1.2 per cent. the vessel took a nasal course, and in 2.6 per cent. more than one such vessel was present.

A coil of anastomosing veins arising from the main trunk on the disc, and forming a network in the macula, was reported by Kraupa-Runk (*Zeitschr. f. Augenheilk.*, 36, p. 217, 1919) who also reports

an arterial anastomosing ring in the left eye of a girl aged 10: a shallow, greyish-green hole was seen in the lower nasal quadrant of the disc from which three cilioretinal arteries arose; these arteries were connected with one another by a vascular ring in the bottom of the hole. The blood stream in this ring did not run regularly; at times it could be seen in the upper, then in the lower part of it; slight pressure on the eye produced granulation of the blood column in it.

Retinal arteries, Cramp of the. See **Retinal arteries, Spasm of the.**

Retinal arteries, Embolism of the. See p. 4287, Vol. VI of this *Encyclopedia*. In addition to this matter the *Oph. Year-Book* for 1912 has a number of interesting references, as follows:

The case of embolism of the central retinal artery reported by Rubert is significant because through the death of the patient the eye was obtained for anatomic study four days after the occurrence of the sudden blindness. The artery was blocked by a compact mass at its division on the disk. The endothelium was proliferating slightly and beginning to invade the mass, but otherwise the vessel walls were normal, and no other vascular disease was noted. The nerve elements of the retina were degenerating, the papilla was swollen, the fovea was free from edema. The retinal opacity he regards as due to the edema, but upon grounds which Coats, who reviews his paper, considers insufficient. A case is reported by Gruening as embolism of the right central artery in a boy of 8 years. The boy, previously considered healthy, awoke in the morning blind in the right eye. When seen later in the day the retinal opacity was typical of embolism, but there were fourteen small hemorrhages scattered over it, and the macular cherry-red spot was seen distinctly in its lateral half only. The retinal arteries were thread-like. The boy had a rough systolic heart-murmur over the pulmonic area. The retina, however, did not clear up, and the appearances remained unchanged five months later. Stephenson, who finds very few records of cases occurring in children, reports embolism of the central retinal artery in a girl of 11¾ years. Blindness was noted on rising in the morning. The opthalmoscopic symptoms were those of embolism. Examination showed mitral regurgitation with slight dilatation and hypertrophy of the left ventricle. At the end of two months the optic disk was white, the retinal vessels smaller than those in the other eye, but light perception had been recovered in the nasal and temporal margins of the field.

Three cases of embolism of the central retinal artery occurring during pregnancy are reported by Teillais. In each case the delivery was normal, but the usual changes occurred in the retina, and the eyes all remained entirely blind. No probable source of an embolus, other

than general blood changes, is suggested. Teillais also includes a case seen by Van Duyse, where there was obstruction of the principal upper branch and the usual effects in the retina above the macula, with loss of the lower portion of the field of vision and reduction of visual acuity to 1/8. This case is also ascribed to the chlorosis of pregnancy.

A case of sudden blindness with the fundus appearances of embolism of the central retinal artery, occurring one week after criminal abortion is reported by Gjessing. Pregnancy had been interrupted at five weeks. Vision was regained in an arched area of the field, and seven weeks after the attack had risen to about 1/6. Softening of the embolus in conjunction with two cilioretinal arteries accounted for the improved vision. A retinal embolism affecting the lower branch of the central artery is reported by Hird. The upper half of the field returned in about ten minutes and improved until 2/3 of the field was restored with vision of 6/6. The embolism was probably from vegetations on the cardiac valves. Van Duyse, in addition to his case of partial obstruction in pregnancy, reports three others. One was of the superior artery with retention of the lower field, but not up to the fixation point. The others were of obstruction of the vessels supplying the central part of the retina causing large central scotomas.

Retinal arteries, Pulsation of the. This subject has been discussed under several (obvious) captions (such as **Blood pressure**) in this *Encyclopedia*. Here attention is drawn to the review by W. C. Souter (*Oph. Review*, p. 117, June, 1916), of the article by Th. de Speyr (*Annales d'Oculistique*, 152, Dec., 1914).

The author first quotes the opinions of a number of authorities as to the existence normally of visible pulsation in the retinal arteries, i. e., visible to an ordinary direct opthalmoscopic examination, and then goes on to show how by the use of the Gullstrand ophthalmoscope and taking movements of the "watered silk" retinal reflexes as indication of pulsation in the arteries, he had come to the conclusion that pulsation in the retinal arteries is a physiological phenomenon.

He quotes Rollet, True, Valude and Frenkel, Adam, Elschnig, Uhthoff, Schweigger and Greeff, Fuchs, Fick, Knies, Michel—all in favor of the view that pulsation in the retinal arteries is always pathological, Michel stating that if arterial pulsation be not seen under normal conditions it is because variations in calibre are not big enough to be seen with the usual magnification of the ophthalmoscope. On the other hand Speyr quotes Marc Dufour as saying with Gonin that arterial pulsations, which in quite healthy subjects seem very often to be wanting or are perceived only after very close attention, often become very

distinct with increase of intraocular pressuure. Schmidt-Rimpler says that the arterial pulse may be observed very rarely in the normal eye. Albert de Graefe saw it twice in orbital tumor cases; Wadsworth and Schmidt-Rimpler at the commencement of a syncope, although this intermittent form of blood wave is agreed to be different from the singular arterial pulsations noted by Quincke in aortic insufficiency, by Becker in exophthalmic goitre, and by Raehlmann in chlorotics, anemics and neurasthenics (and by others in glaucoma and on pressure of the eyeball), where the arteries at bifurcations especially show swellings, sometimes with redness and pallor of disc, a phenomenon which may be seen at one time and not at another in the same individual. Haab says that a very careful examination generally shows pulsatile movements even in the retinal arteries of normal subjects, but as a rule only where they describe a curve. In and about the disc where an artery bends sharply there will one find pulsation always, especially where there is a double bend, this pulsatile locomotion being more visible and more frequent than the actual variation of calibre. Lastly Kümmell is quoted as having used Gullstrand's ophthalmoscope and found that the powerful enlargements allowed him to find in all healthy individuals the arterial pulse even in the finest ramifications, as well as the venous pulse.

In the first half of 1915 Speyr made observations in 130 cases on the retinal reflexes as seen in the juvenile retina with moderately high powers of the Gullstrand, and had not directly observed pulsation of the arteries. These "watered silk" reflexes sometimes accompany the vessels for long distances, but are best seen at bifurcations and in angles and curves. Speyr says these originate in the minute angular cavity formed between the wall of the vessel and the surface of the adjacent retina. This kind of gorge reflects the light irregularly, and so the smallest pulsatile movement in the vessel must modify the shape of the reflex. These movements are rhythmical, noticeably synchronous with the radial pulse, and according to Speyr are undeniable proof of pulsation of retinal vessels. These reflexes are best seen in young subjects, disappearing after twenty-five. Children below 8 or 10 years cannot fix well enough to give a good observation, while squinting, amblyopic, nystagmic eyes are impossible, as well as very nervous and mentally feeble people. Most of the cases were aged 10-20, they had normal eyes apart from refractive errors, for which they were under care. The arterial and venous pulses were noted in almost all the cases with normal retinal reflexes whatever the sex or refraction, while in certain cases the retinal reflexes were absent in one eye, pulsations were noted only in the other eye. In other cases where in one or both

eyes the retinal reflexes were very slight no pulsations were noted. Out of 130 cases, 60 males gave 50 arterial pulsations, and 70 females gave 65, i. e., 115 cases gave a positive result on at least one side, 88.5 per cent. As regards the refraction in 260 eyes—of 29 emmetropic eyes 26 showed pulsations, of 123 H. and H.Ast. cases 99, and of 108 My. and My.Ast. cases 70 were positive, making 195 out of 2606 eyes. See, also, the heading **Pulsation.**

Of 29 eyes which did not show arterial pulsations and in which the intensity or absence of the reflexes was recorded, these were normal in 1 case, feeble in 11 cases and absent in 17 cases. The venous pulse frequency coincided with the arterial. Speyr says his cases were mostly young subjects because of the highly developed reflexes they show, but he thinks there is no reason why arterial pulsations also should be limited to this age although the method employed could not be applied to older people. If the pulse of the retinal artery has been hitherto considered as pathological that was due to insufficient means of examination at our disposal.

Ballantyne's (*Oph. Year-Book,* p. 209, 1913) study of the arterial pulse in the human retina is based upon a careful review of the literature of the subject, and the examination of 319 patients in the medical wards of a general hospital, and one hundred out-patients who came to the eye clinic for correction of errors of refraction. He describes and explains: 1. The locomotor pulse, a rhythmic displacement of the artery almost synchronous with the cardiac systole, seen where the artery curves as a movement toward the convexity; or where the artery bifurcates in a movement in the direction of the blood current. 2. The expansile pulse, a broadening of the blood column, or more readily distinguished, of the central light streak, seen equally well where the vessel is straight. 3. The capillary pulse; a variation in the tint of the optic disk, or an increase of the pinker part of the disk at the expense of the pale portion. 4. The pressure pulse, a rhythmic collapse or disappearance of the artery, observed spontaneously in glaucoma or produced by pressure upon the eyeball—"collapsing pulse" or "intermittent inflow" describe it better.

Ballantyne does not regard these as independent phenomena, but as different manifestations of the pulse wave which passes in the arteries of all normal eyes. The blood pressure, the intraocular pressure, and especially the "pulse pressure," or a difference between the diastolic (minimum pressure) and the systolic (maximum) are the most important factors. Changes in the average blood pressure alter the relations between the two, and affect the retinal pulse. Ballantyne

claims in his hundred refraction patients to have recognized the "locomotor pulse" in thirty-six, in three of which was also recognized the "expansile pulse." His medical cases exhibited a "locomotor pulse" alone in 23.5 per cent.; the expansile pulse in 10 per cent.; the capillary pulse in 4 per cent., and the pressure pulse in one case.

Ballantyne concludes: The locomotor pulse is to be considered physiologic, at least not pathologic. Excitement may be responsible for its temporary appearance. The expansile pulse occurs in healthy persons but not nearly so frequently. Usually it is associated with incompleteness of the aortic valves. The capillary pulse occurred in about one-half the cases that showed the expansile pulse and is rarely seen apart from the aortic regurgitation. The pressure pulse aside from glaucoma is seen in aortic regurgitation, and in syncope. Onishi believes that the pulsation of the central retinal artery is always, although slightly, visible under a strong magnifying power. He can also see it entoptically when looking at an illuminated surface.

Retinal arteries, Sclerosis of the. See **Retina, Angiosclerosis of the.**

Retinal arteries, Spasm of the. INTERMITTENT ISCHEMIA. CRAMP OF RETINAL ARTERIES. This subject has already been discussed under **Cramp of the retinal vessels,** p. 3550, Vol. V of this *Encyclopedia.*

Arnold Knapp (*Jour. Am. Med. Assocn.*. p. 2118, June 25, 1910) notes that disturbances of the retinal circulation causing loss of vision are exceedingly complex, and are still imperfectly understood. There are unquestionably some conditions which are not due to embolism or thrombosis. Temporary obscurations are not infrequent clinical manifestations of a disturbed retinal circulation, and they often precede permanent, partial or complete blindness.

These attacks of temporary obscuration were formerly attributed to embolism; the plug supposedly at first obstructed the main trunk of the retinal artery, and later lodged in a branch. This theory was later abandoned, because of the number of recurring attacks without any evidence of the subsequent fate of the embolus.

Intermittent closing of healthy retinal arteries may occur without any lasting effect on vision. In diseased retinal vessels this phenomenon is of grave significance, as the vessel may remain obstructed or lead to thrombosis. In subjects with retinal arteriosclerosis, especially if obscurations have been present, a rigid general treatment of the arteriosclerosis should be given, mainly with a view of preventing any of the causes which seem to contribute to closing of the arteries.

Weiss (*Oph. Year-Book*, p. 240, 1912), reports the direct ophthalmoscopic observations of spasm of the retinal vessels, causing temporary amaurosis. The arteries first contracted until they appeared as

yellowish-white cords, and contraction of the veins followed. The optic disk became quite white. In the veins remained a sharply interrupted blood column, which moved from the disk toward the periphery with certain movements of the eye. In one-half hour the vessels refilled, beginning with a small cilioretinal branch, and then slowly the larger arteries regained their calibre. There was vascular spasm of the fingers of the left hand. See, also, **Retina, Ischemia of the.**

Retinal arteries, Thrombosis of the. This condition may be due to cardiac or vascular lesions, or, as has been observed by Siegrist and Gifford, it may follow ligation of the deeper vessels of the neck. In the first two cases observed by Siegrist after ligation of the common and internal carotid arteries the eye of the same side became blind. The ophthalmoscopic picture was similar to that which is found in embolism and in thrombosis of the central retinal artery. The autopsy showed a thrombosis of the internal carotid, ophthalmic, and central retinal arteries. In Siegrist's second case ligation of the internal and external carotids was followed by blindness, by a similar fundus picture, and by atrophy of the retina with pigment accumulation.

The ophthalmoscopic picture of thrombosis is similar to that of embolism. Premonitory symptoms in thrombosis are attacks of transient blindness in both the diseased eye and its fellow, headache, giddiness, and faintness. These symptoms are rarely present in embolism.

The diagnosis between thrombosis and embolism is difficult, not only clinically, but also microscopically. Thus, of 15 cases of supposed embolism of the central retinal artery which are recorded in literature as having been subjected to microscopic study, Marple states that in 4 no embolus was found, in 5 it was impossible to say whether the condition was embolism or thrombosis, and in only 6 was an unmistakable embolus found. It is necessary to study such specimens in both longitudinal and cross sections.

Von Michel attributed thrombosis to arteriosclerosis. It is possible that spasm of the muscular coat of the artery is an etiologic factor. Sachs observed the formation of a ring of constriction on one of the retinal arteries, which began on the physiologic cup, and extended to the bifurcation of the artery. Similar constrictions followed at short intervals. The case was one presenting the ophthalmoscopic signs of retinal embolism and the observation was confirmed by Fuchs. Galezowski believes that, in cases of supposed embolism in which no probable source for the embolus could be found, the condition was really thrombosis due to endarteritis.—(J. M. B.)

An example of thrombosis of a sclerosis retinal artery without signs of general arteriosclerosis is reported by H. Maxwell Langdon (*Prac. Med. Series,* Eye, 1914). A man, aged fifty years, by occupation a watchmaker, complained that after doing a difficult piece of watch repairing he found the vision of the left eye blurred, especially in the upper field. The central vision of the right eye was 6/20 and the left 6/10. Corrected central vision was 6/5 in each eye, with a slight eccentric vision in the left. Externally the conditions were normal. The media were clear, both disks were normal, with good color and clear margins. The arteries of the right eye showed a slight increase in the light streak, and some irregularity of caliber, especially in the superior nasal branch. In the left, the conditions were much more marked, the arteries being decidedly sclerotic, with the lower branch apparently thrombosed, the entire lower portion of the retina being edematous, and the course of the retinal vessels obscured. His personal and family history were negative. The urine was normal with a specific gravity of 1,020. There was no albumin or sugar. The pulse was 74 and the blood pressure 165 systolic. He had a mitral regurgitant lesion. The Wassermann was negative.

The same author (*Trans. Coll. Phys. Phila.*, Apr. 17, 1913), also reports a similar case of a man, aged twenty-six years, color-matcher in an ink factory. There was no previous ocular trouble except occasional severe frontal headaches, especially over the left eye. Five days before he was seen the vision of the left eye became suddenly blurred, especially in the lower portion of the field, and including central vision. On examination, no external abnormalities were noted. Ophthalmoscopically the right eye was normal with about 1.5 D. of hyperopia. The left had clear media, with a normally-colored disk, with clear margins. The retinal vessels were normal except the superior temporal artery, which seemed to suddenly disappear in a mass of retinal edema. There was little or no pigment change, and no hemorrhages. The central vision was 6/60 and that of the right was 6/5. The personal and family history were negative, Wassermann negative, tuberculin test and physical examination negative for tuberculin. The urine was negative; systolic blood pressure, 135; pulse, 72; hemoglobin, 89 per cent.; reds, 4,600,000; whites, 7.500; heart normal. In short, a most complete physical examination made by Dr. William Drayton was absolutely negative. The retinal edema disappeared under iodides, and the artery was seen as a bloodless, shrunken, shiny line. The central vision rose with the correction of a fairly high astigmatism to 6/10 eccentric, but the changes in the field still persisted.

Retinal asthenopia. See **Amblyopia, Hysterical,** p. 299, Vol. 1; **Neurasthenia,** p. 8323, Vol. XI, as well as the various **Asthenopia** rubrics, p. 651, Vol I of this *Encyclopedia.*

Bernard Cridland (*Ophthalmoscope*, Aug., 1914), in his discussion of the essay of Aubineau (*Archives d'Ophtalmol.*, May, 1914), remarks that with the progress of time "retinal" or "nervous asthenopia" has steadily established itself as a clinical entity, distinct from accommodative or muscular asthenopia.

Aubineau finds that it is frequently met with in practice, and regards it as an ocular manifestation of "asthenia," employing the term in the sense that it is now used in psychiatry.

The symptomology is purely subjective, and the trouble consists in the inability of the patient to use the eyes for a sustained effort, more or less long according to the individual, and more marked for near vision, which of necessity involves a greater effort. An attempt to continue reading is often followed by an ocular or orbital discomfort rather than an actual pain, a sensation of smarting in the lids with a desire to close them leading to somnolence. The retinal asthenope is usually much reassured with a prescription for convex glasses, but his satisfaction is of short duration, for they fail to cause the ocular fatigue to disappear. The condition is not confined to emmetropes, for in a patient with retinal asthenopic symptoms there may be superadded those due to a refractive error or muscular imbalance. These are quite distinct, however, and disappear on correction with suitable glasses, whilst those due to retinal asthenopia persist.

Aubineau has tabulated 74 cases of retinal asthenopia. The age of the patients varied from 11 to 65 years. Thirty-one were males and 43, females, the predominance of the latter being explained by their greater exposure to fatigue by reason of their sex. Forty-two cases were emmetropes and 26 were ametropic, chiefly hypermetropic, but including 2 cases of astigmatism and 4 myopes. In nearly all the cases the muscular balance was normal; 2 only showed slight insufficiency of convergence.

In one-fourth of the cases there was in the antecedents evidence of congenital or acquired taints, neuropathic or psychopathic phenomena, and the author is inclined to the view that heredity plays an even greater part in the etiology than this proportion would indicate. In more than sixty per cent. of the cases there was a clear history of either moral disturbance, mental or physical overwork or a change in the organism following an operation, an infection or pregnancies. In four post-operative cases chronic alcoholism was present. The dominant

symptom which accompanies retinal asthenopia is a general depression and is rarely found wanting.

In addition, there may be loss of memory, impairment of will-power, emotion and anxiety. Two of the author's cases required detention, one of which presented periods of asthenia interrupted by crises of excitement. Headache, insomnia, spinal pain and gastro-intestinal troubles may accompany the depression. The whole is a picture of the neurasthenic state and so commonly found associated with retinal asthenopia that the presence of the latter alone is sufficient to warrant a diagnosis of the former. The prognosis depends directly upon the degree of the neurasthenia, and the most favorable amongst the author's cases were those following overwork.

The term ''retinal asthenopia,'' created by Meyer, is, in Aubineau's opinion, a reasonable one, as being indicative of an origin independent of the ocular musculature, but he prefers the American designation, namely, ''asthenic neurasthenia,'' as a more logical term, notwithstanding the pleonasm in the etymology of the two words.

In conclusion, Aubineau sums up as follows: 1. ''Retinal asthenopia'' is a condition in itself, a special ocular fatigue characterized by troubles of the visual application which renders a sustained effort of vision an impossibility. It is independent of and distinct from the accommodative asthenopia of Donders and the muscular asthenopia of von Graefe. 2. ''Retinal asthenopia'' is always associated with a neurasthenic condition.

Retinal bloodvessels, Arteriosclerosis of. See **Retina, Angiosclerosis of the.**

Retinal bloodvessels, Atrophy of the. This condition is universally a secondary change. It is characterized by a uniform diminution in the size and lumen of the vessels. Retinitis pigmentosa, optic nerve atrophy, embolism, thrombosis, angiosclerosis and destructive changes in the retinal tissues are the commonest causes of this disease.

Retinal bloodvessels, Hemorrhage from. See **Retina, Hemorrhage into the.**

Retinal coloboma. See **Congenital anomalies.** Congenital coloboma at the macula could be seen in both eyes of a boy, a patient of Weeks (*Archives of Ophthalm.*, p. 307, 47, 1918); the defects were irregularly circular and appeared to affect retina and inner layers of the choroid only. Plentiful retinal pigment at the margin and scattered pigment in the defects were present. These colobomas were not caused by defective closure of the optic cleft but due to defective development of the choriocapillaris, as already advanced by Collins and Mayou.

Retinal cones. Bulbous bodies in the layer of rods and cones of the retina. They are divided into two segments, an inner (the cone body), and an outer (the cone rod), which is usually shorter. The inner is bottle-shaped, consists internally of homogeneous or finely granular matter, externally of fine fibrils, is simply refracting, is stained by carmin, and is continuous with a cone fibre. The outer segment is finely tapering, doubly refracting, is uncolored by carmin, but deeply stained by osmic acid, and is believed to be made up of superimposed discs. By some they are regarded as the peripheric process of the cone granules (bipolar ganglion cells), and as being more largely concerned in the perception of color than the rods. In animals of nocturnal habits they are much diminished in number, or are absent. They are usually fewer in number than the rods, except at the macula lutea, where they exceed the rods in number. They are perpendicular to the retina except at the macula, where they are somewhat oblique. (Foster.) See, also, **Cones of the retina**, p. 2773, Vol. IV of this *Encyclopedia*.

The widely accepted view that the cones are the only retinal organs for the perception of color is opposed by Siven (*Oph. Year-Book*, p. 211, 1913) who brings together many observed facts from experimental and comparative physiology to support his contention, that the rods are the organs which are concerned in the perception of color of short-wave lengths.

Retinal cysts. See **Retina, Cyst of the.**

Retinal disease with massive exudates. These cases are said by Coats (*Royal London Oph. Hosp. Reports*, Vol. 17, part 3, p. 440), to form a fairly well-defined group. They are characterized by the presence in some part of the fundus of an extensive mass of exudation. In some instances peculiar forms of vascular disease are also found. Inasmuch as the most careful physical examination commonly fails to discover any probable etiology, no certain diagnosis can usually be arrived at from the clinical standpoint. The records of pathologic examinations in such cases are extremely scanty.

The author's conclusions are as follows: There is a disease of the retina, hitherto insufficiently differentiated, which is characterized by the presence in the fundus of large masses of white or yellow exudation; usually there are also groups of cholesterin crystals and hemorrhage. The affection occurs in young people, most commonly of the male sex, whose general health is usually perfect. No definite connection with former illness can be established; nor does the family history as a rule reveal anything of importance. The commencement is commonly unnoticed, and the course very slow; in some instances

the eye-sight is lost from detachment of the retina, secondary cataract, iritis, or secondary glaucoma; in other instances quiescence is attained before these results ensue.

In an allied form of the disease, or in a variety of the same form, strange types of vascular disease are found—fusiform and globular expansions, kinks, loops, glomeruli, etc., as well as the more common types, such as constriction, white ensheathing, etc. The other characters of this group are similar to those of the first, but probably, in consequence of the vascular disease, the cases are less often quiescent, and are more frequently followed by the injurious sequelæ just mentioned.

In the only case of this disease which has so far been examined in a recent stage, the white mass in the fundus was found to be due to a disintegrating hemorrhage seen through a retina which was thickened and infiltrated with swollen leucocytes. The hemorrhage was connected with the outer strata of the retina, and was therefore presumably derived from the capillaries of the outer reticular layer, the most external layer in which capillaries normally occur. It had broken into the subretinal space, and at its periphery slow organization was taking place. The choroid had practically no share in the process. The opaque exudation seen in the fundus apart from the main mass was due to crowds of swollen leucocytes in the subretinal space.

In the subsequent course of the disease, as shown by the other, older cases, the process of organization is completed and cicatricial contraction sets in, crumpling up the retina and causing further detachment. The hemorrhage breaks down completely and may be totally absorbed; more usually, however, a small cavity remains among the cicatricial tissue, filled with débris, cholesterin crystals, and calcareous particles. The exudate is now absorbed, except when vascular disease is present, and gives rise to new hemorrhages.

The exact significance of the vascular changes in some cases is not yet fully made out. They occur in three chief forms: dilatation with little change in the wall; thickening of the wall with hyalin degeneration and nuclear fragmentation; collections of inflammatory cells in the wall and in the perivascular lymph spaces. Some, perhaps all, of these changes are probably secondary to obstruction caused by cicatricial contraction, and to the action of low grade irritants, such as are always produced by disintegrating blood, constituting the stimulus to the surrounding tissues, which result in the chronic inflammatory process known as organization. On the other hand, it is possible that some of the vascular changes are primary and the cause of the hemor-

rhage; but against this explanation are to be set the youth of the patients, and the fact that the disease is commonly unilateral. Other possible explanations of the hemorrhage are: hemorrhage at the time of birth, hemorrhage due to constitutional conditions, perhaps associated with alterations in the coagulability of the blood, and perhaps, in exceptional cases, hemorrhage due to strain and injury. It is probable that no single hypothesis will cover all the cases.

There is another form of disease, also with massive exudation in the retina, which is characterized by the formation of arterio-venous communications and enormous enlargement of the affected vessels. In the youth of the patients attacked, in the absence of an evident etiology, and in its general course and termination, it has many points of resemblance to the cases already mentioned, and possibly it is allied to them. The few pathologic examinations that have been carried out do not altogether support this, but speak rather of a true vascular new formation in the retina. In the meantime, therefore, it is better to classify them separately. See, also, **Retinitis exudativa.**

Retinal embolism. See **Retinal arteries, Embolism of the**; as well as **Embolism of the central artery of the retina**, p. 4287, Vol. VI of this *Encyclopedia.*

Retina, Leopard. TIGER RETINA. The appearance of the retina in chronic *retinitis pigmentosa* (q. v.).

Retinal fatigue. A state of decreased sensitiveness of the optic nerve.

Retinal hemorrhage. See **Retina, Apoplexy of the.**

Retinal horizon. The horizontal plane which passes through the transverse axis of the eyeball.

Retinal hyperesthesia. IRRITATION OF THE RETINA. IRRITABLE RETINA. See **Retina, Hyperesthesia of the.**

Retina, Light-streak in the. See **Light reflex**, p. 7479, Vol. X of this *Encyclopedia.*

Retinal image. The image formed upon the retina by rays of light passing from an outside object through the visual mechanism of the eye. See the various **Image** headings on p. 6169, Vol. VIII of this *Encyclopedia.*

Retinal ischemia. A condition of blood stasis in the arteries of the retina, usually accompanied by hyperemia of the veins, caused by pressure on the vessels in the trunk of the optic nerve or in the orbit, or by embolism or thrombosis. See **Retina, Ischemia of the.**

Retinal periphlebitis. See **Retina, Juvenile diseases of the**; and **Periphlebitis retinalis**, p. 9610, Vol. XII of this *Encyclopedia.*

Retinal perivasculitis. See **Retinal periphlebitis.**

Retinal pigmentation. See **Retina, Pigmentation of the.**

Retinal pigment layer. A layer of pigmented epithelial cells forming the innermost lining of the retina, choroid, ciliary body, and iris. Embryologically, it is part of the retina.

Ruth B. Howland (*Journ. Experimental Zoology,* II, No. 2, 1912; review in *Ophthalmology,* p. 293, Jan., 1913), has made observations with Branchipus, a Phyllopod, with a view to determine the effect of varied heat and light on the migration of the retinal pigment. The effect of light and dark on the movement of pigment granules in the eye of *Branchipus gelidus* is in the nature of a readjustment rather than a proximal and distal migration. The distal pigment is not influenced by variation in light intensity. In light, the pigment granules collect closely around the rhabdoms, protecting them from too intense stimulation. In the dark, the granules move laterally and are readjusted so that they become more evenly distributed through the cytoplasm of the retinular cells. The time occupied in complete readjustment is between four and one-half and five hours. The cytoplasm of the retinular cells serves as a reflecting apparatus in a weak light in the absence of accessory cells. Changing temperatures have no appreciable effect upon pigment migrations, higher temperatures causing almost instant death. *Branchipus gelidus* is positively phototropic. Animals exposed to light after remaining in the dark five hours were negatively phototropic.

Retinal points, Corresponding. Identical points. See p. 3539, Vol. V of this *Encyclopedia.*

Retinal pulse. See **Retinal arteries, Pulsation of the**; as well as **Pulsation, Retinal,** p. 10530, Vol. XIV of this *Encyclopedia.*

Retinal purple. Visual purple or rhodopsin; a photo-sensitive pigmentary substance occurring in the outer segments of the retinal rods.

Retinal rods. Cylindrical bodies, consisting of an inner and outer segment cemented together, in the layer of rods and cones of the retina.

The *Oph. Year-Book* for 1912 has the following reviews: Thierfelder calls the rods and cones visual cells, and supposes that to each is fixed a cell of the outer nuclear layer, which he terms a cell of regeneration. The visual cell contains molecules sensitive to light. These are assumed to be of different sizes, each acted on by light waves of a definite length. In this sense he calls them red molecules, green molecules, etc. The terminal nerve fibrils line the visual cells, each tuned to one kind of light stimulus. By the action of light the molecules are set in motion and act on the corresponding fibrils, with a sudden discharge of accumulated energy. Then the exhausted molecules pass

into the cells of regeneration, to again become sensitized by a comparatively slow process. In the transition from light to sensation he assumes, not an active transformation of light energy into chemical and thence into nerve energy; but a sort of relay system, in which the light sets up a change in the chemical energy circuit, and that in turn excites the discharge of nerve energy.

Hertel finds that the limits of the objective effect of light on the retina, shown by contraction of the rods, conform closely to the limits of the subjective effect, about 350 microns to 400 microns for short wave, and 820 microns to 840 microns for long wave light. Von Kries elaborates the hypothesis that the retina has a duplex function, vision by strong light being performed by the cones, the function of the rods being abolished, perhaps by destruction of the visual purple; while the rods are the principal organs of vision in very feeble light, and the relative importance of the two varies in intermediate illuminations. Edridge-Green believes that the rods are concerned only with the formation and distribution of visual purple. Only through the cones are visual impulses set up and sent to the brain. See p. 5962, Vol. VIII of this *Encyclopedia*.

Retinal separation. See **Retina, Detachment of the.**

Retinal suppuration. See **Retina, Abscess of the.**

Retinal syphilis. See **Retina, Syphilis of the.**

Retinal thrombosis. See **Retinal arteries, Thrombosis of the**; also **Retinal vein, Thrombosis of the.**

Retina, Lues of the. See **Retina, Syphilis of the.**

Retinal vasculitis. See **Retina, Juvenile diseases of the**; also **Periphlebitis retinalis,** p. 9610, Vol. XII of this *Encyclopedia.*

Retinal vein, Thrombosis of the. See p. 1962, Vol. III of this *Encyclopedia.*

Retinal vessels, Sclerosis of the. See **Retina, Angiosclerosis of the.**

Retinal vessels, Spasm of the. See **Retinal arteries, Spasm of.**

Retina, Lymphorrhagia of the. See **Lymphorrhagia, Retinal.** Gonin records the case of a man aged 28, who without known cause noticed sudden loss of vision in his right eye and showed dilated veins and narrowed arteries, with numerous small hemorrhages in the retina. There was extensive milk-white extravasation extending from the disk to the macula, and other smaller ones. The appearance resembled what is sometimes seen after fracture of the skull. Gradually it cleared up, leaving the disk atrophic and no vision. The other eye remained healthy. Purtscher reports five cases of lymph extravasation in the retina following head injuries likely to cause excessive intracranial pressure. Around the disk toward the macula, and extending

out three to six disk diameters along the veins, were white oval or rounded spots measuring one-fifth to one disk diameter. He thinks these spots are related to the lymph channels. This relation explains their distribution in both disease and trauma.

Retina, Melanoma of the. An example of this extremely rare, malignant, retinal neoplasm is reported by John Griffith. See p. 7632, Vol. X of this *Encyclopedia*.

Retina, Miliary aneurysm of the. Miliary aneurysms of the retina are classified by Leber (*Oph. Year-Book,* p. 236, 1912), in two groups. In one they arise by senile changes in the vessels without inflammation; and cause no tissue change in the retina except small hemorrhages. In the second group the cases are characterized by gross retinal lesions that suggest a similarity to retinitis circinata. Leber thinks the disease of the vascular system is the primary feature, and the degeneration of the retina with opacity is secondary. He finds eleven cases of this class in the literature and adds two of his own. In his first case, that of a man aged 25, there was detachment of the retina and small red spheres which appeared to be connected with the vessels. There was catarrh at the apex of one lung, and tuberculin injections caused pyrexia and a mild local reaction. With the ophthalmoscope the disk and large vessels usually appear normal. The aneurysms form at the ends of small arteries, or sometimes on veins. They are often surrounded by small hemorrhages. Aneurysms only occur in the region of opaque retinal degeneration and in a zone immediately surrounding this. The disease usually runs a chronic course, and affects but one eye. But it may be bilateral and more acute. See, also, p. 462, Vol. I, as well as p. 7705, Vol. X of this *Encyclopedia*.

A case of multiple aneurysms of the retinal arteries, well depicted in a plate, is reported by J. A. Pringle (*British Jour. of Ophthalm.,* p. 87, Feb., 1917). The paper is largely quoted as follows:—Private C. J., aged 23, service 7 months, complained of some blurring of vision. He first noticed it eighteen months previously. When he stooped and raised his head quickly, his eyes ached at the back, and "discs" and "rings" seemed to float in front of him. He was a fairly well-developed man, apparently healthy, save for a slight tendency to anemia. There was no sign of thickening of the peripheral arteries. The urine was reported normal.

Father alive; said to have diabetes, but no eye trouble. Mother died of cancer. Four brothers and one sister, all healthy, and nothing wrong with their eyes, as far as he knows. No history of tubercle or syphilis.

Patient has always been healthy, no serious illness, no injury; has never worn glasses. He started work as a miner when 16½ years of age, and worked constantly in the pits until two months before enlistment, when he went off work, owing to his vision becoming blurred, and things seeming to go round. There is nothing to note externally in either eye; pupils equal and active; tension normal. Slight nystagmus can be elicited in extreme positions of the eyes.

R.V.=6/6 c.+0.5 D. cyl. axis 45°=6/5 partly and J.1.

L.V.=6/5 partly. No refractive error.

L. fundus.—There is some increase of connective tissue round the disc and along the vessels, but there is no sign of medullation at the disc. On following the superior temporal vessels outwards for about 2½ to 3 disc diameters, a large patch of medullated nerve fibres begins to make its appearance. These fibres start as a compact opaque bundle along the course of the vein, and gradually spread out on either side into long, fine, silvery threads which follow the line of the main vessels, and gradually fade off into the normal retina about 3 disc diameters farther out. At one point the upper of the two main branches of the superior temporal artery crosses behind the vein, and here the artery is almost completely hidden by these fibres. Still farther out, and at a lower level, there is another area of medullated fibres, but this patch is much smaller than the first, and is poorly-defined, being represented merely by a few faint, silvery lines running across the course of the lower branches of the superior temporal vessels.

In the fundus are three large swellings along an artery immediately below the first-mentioned patch of medullated fibres; two of these swellings are pale-pink with bright reflexes, which gives them a pearl-like appearance, while the third or centre one is of a deep-carmine color.

The artery along which these swellings are situated presents several other features of interest; following its course outwards from the disc and describing in detail each abnormality as it presents itself, one finds:—The superior temporal artery divides into two branches of equal size at a short distance from the disc. The upper branch follows the course of the vein, crossing first in front of this vessel, and then, at a short distance farther outwards, recrossing behind it. It is upon the lower branch, which runs above the macula and is not involved in the area of opaque nerve fibres, that the aneurysms occur. After giving off two twigs to the macular region, this artery sends a small branch almost vertically upwards and just beyond this point, which is about 3½ to 4 disc diameters from the

Pringle's Case of Multiple Aneurysms of the Retinal Arteries.

papilla, there are two small, oval, brightly-reflecting spots of a white or pearl-grey color, lying one beyond the other on the centre of the vessel, with their long axes parallel to its course. There is no increase in the calibre of the artery, and beyond the fact that its normal central light reflex is interrupted by these two spots and that the vessel behind them, except where they actually hide it, shows pink in color, there is nothing further to note. Immediately beyond the second of these two dots is a large fusiform expansion, bulging below rather more than above and in size about 3½ times the diameter of the vessel. At the peripheral end of this expansion and before the calibre again becomes normal, there is a second smaller fusiform expansion about twice as large as the diameter of the vessel. In shape these two are like the two bulbs of the old-fashioned soda-water syphon, the length of the first being about four times, and of the second about twice the diameter of the vessel. The appearance of the first expansion is very striking and can best be compared with that of a pale-pink pearl. On the summit of this expansion and slightly below its centre there is an oval area with bright reflex similar in appearance to that of the first two just described, but longer. Curving above and below this reflex can be seen the pale-pink shading of the blood-stream, which has a flattened-out appearance; but this, as well as the color, is probably due to the fact that the blood is seen through a thickened vessel wall. The second or smaller expansion is also pale-pink in color, with a marked reflex on its upper part. It also shows the usual bright oval reflex on the summit. The lower part has a deeper pink color, probably because here the blood-stream does not appear to take a straight course through the expansion, but fills its lower half, which apparently has comparatively thin walls, while the walls of the upper half seem to be considerably thickened.

For a short distance beyond this point the artery is normal in all respects. It is crossed transversely by a branch of the superior temporal vein, and gives off a small twig below. Next comes a third pearl-grey spot on the anterior surface of the vessel, similar to the two first described. Here, however, the vessel shows a very slight increase in calibre, but the walls do not appear to be thickened. Narrowing a little, but still with a somewhat increased calibre and curving gently upwards, the artery expands into the fourth and most typical of its aneurysms.

In shape this is exactly like the bulb of a Higginson's syringe, measuring about 3½ diameters of the normal vessel in breadth and 4 to 4½ diameters in length. It is of a deep-pink or carmine shade throughout, except at its centre, where it shows a bright oval reflex.

The walls appear thickened, as they have a distinct whitish outline, but the whole expansion is perfectly uniform and is apparently completely filled with blood.

Beyond this dilatation the artery becomes perfectly normal for a short part of its course, and is crossed by another twig from the superior temporal vein. It takes a gentle curve downwards, and just at the bottom of this curve it shows yet another dilatation. This one is a reproduction of the first two, but is smaller, being scarcely twice the width of the vessel; it has the same appearance of a pale-pink pearl, and seems to bud out from the anterior wall of the artery, corresponding in appearance rather with the sacculated type of aneurism. The blood-stream can be seen passing behind rather than through its proximal part, the walls of which appear much thickened, while its distal part takes on a deep pink color, and seems to become full of blood as it gradually diminishes to approximately the normal diameter of the artery.

The farthest out and smallest expansion follows almost immediately on the last-described before the vessel has quite regained its normal size. It seems to spring from the posterior and upper aspect of the artery, showing above the vessel as a small refractile hemisphere, the slightly enlarged artery hiding its lower half. In size it is only about half the width of the vessel, and is probably composed of thickened wall, as the line of the blood-stream can be seen passing across it. For a short distance, about 2 to 3 disc diameters, beyond this expansion, the vessel is slightly enlarged, but shows no thickening or irregularity of its walls; while for the rest of its course in the ophthalmoscopic field, it is perfectly normal.

In the retina, a little way below the first aneurysm, there is a minute refractile spot, and on close examination, one can make out a second still more minute grey speck below the Higginson's syringe expansion. No blood-vessel is in connection with either of these.

No enlargement of either the arteries or the veins on the papilla is apparent, nor can the slightest abnormality be detected on any other of their branches as far as they can be traced towards the extreme periphery of the fundus. As compared with the retinal vessels on the disc of the other eye, beyond the fact that the left superior temporal vein is a little fuller than the right, no difference is observable.

The branch of the artery on which the aneurysms occur is normal in every respect up to the point where the first refractile spot appears. There is no spontaneous pulsation, either in the arteries or in any of the expansions. The venous pulse was well marked on both discs. Pressure on the globe gave very distinct pulsation in the arteries, and

this pulsation could be traced into the branch with the aneurysms; no artificial pulsation in any of the aneurysms themselves or in the artery beyond.

R. fundus.—The inferior temporal and inferior nasal arteries and their branches show dilatations similar to those described in the left eye. The majority of these swellings are situated at the extreme periphery of the fundus, but, owing to the slight nystagmus, they are difficult to see, and impossible to examine in detail. In all, 23 dilatations of varying size appear in the ophthalmoscopic field, 9 of these being situated on the inferior temporal artery and its branches, and 14 on the inferior nasal artery and its branches. They are of exactly the same type as those in the left eye, but are rather smaller in size, possibly because they are more peripherally situated. In none of them, nor in the fundus in their immediate neighborhood, can any sign of recent changes be detected. Both arteries show some apparent thickening of their walls at one or two points in their course between two dilatations; but otherwise, except for the aneurysms, they appear normal. Towards the periphery of the field, and lying above the main branch of the inferior temporal artery, some white markings appear in the retina, which are probably of a similar nature to those described in the left fundus immediately between the two larger dilatations. There is evidence of an increase of connective tissue around the disc and along the vessels in its neighborhood.

Retina, Neurinoma of the. NEUROCYTOMA OF THE RETINA. Elschnig (*Oph. Year-Book*, p. 325, 1913), describes a tumor which he regards as derived from the developmental cells of the retina in the region of the ora serrata, and to which, following Verocay, he gives the name neurinoma or neurocytoma. It occurred in a boy of 15 years, and consisted of a fibrous basis, with a great wealth of epithelioid cells, and here and there tortuous blood vessels and hyaloid deposits.

Retina, Neuroblastoma of the. A name given by Mallory to *glioma of the retina*.

Retina, Neurocytoma of the. See **Retina, Neurinoma of the.**

Retina, Neuro-epithelioma of the. The name given by Flexner to glioma (retinæ). See **Retina, Glioma of the.**

Retina, Opaque nerve-fibres in the. MEDULLATED NERVE FIBRES. See **Nerve fibres, Opaque,** p. 8314, Vol. XI; also p. 2939, Vol. IV of this *Encyclopedia*.

Retina, Operations on the. See **Retina, Detachment of the.**

Retina, Perithelioma of. See **Perithelioma,** p. 9612, Vol. XII of this *Encyclopedia*.

Retina perversa. INVERTED RETINA. Tissue formation exhibiting ret-

inal elements irregularly arranged. See, for example, **Retina, Cyst of the**; also p. 2822, Vol. IV of this *Encyclopedia*.

Retina, Pigmentary degeneration of the. See **Retinitis pigmentosa.**

Retina, Pigmentation of the. In addition to the matter on p. 10221, Vol. XIII of this *Encyclopedia*, the following is of importance.

Höeg pictures a form of pigmentation (see, also, Frost's *Fundus Oculi*, plate X), usually grouped over a section of the eyeground, the macula being immune. The pigment spots are sharply-defined, may be black or dark-gray, and in their grouping show no relationship with other changes in other parts of the eyeground. Sight is not affected. Four cases are recorded. The author believes this anomaly to be due to irregular formation of the hexagonal pigment layer. In a case reported by Meisner there was a small coloboma of the retina, and aplasia of the optic nerve; with deep opacities of the cornea, absence of anterior chamber and poor development of the uveal tract throughout.

Burton Chance (*Ophthal. Rec.*, April, 1915), refers to four cases of Stephenson's *(congenital) pigmentation* (1891). That observer had met with three cases only of this description in an examination of 2,500 eyes, and he was inclined to regard the condition to be commoner than might be inferred from the scantiness of the literature existing at that time.

The first case was noticed in the left eye of a boy of 10, who was sent, with a number of boys in October, 1910, for a routine examination of the eyes.

In the upper nasal section of the fundus of this boy's left eye, there were a number of groups of spots which extended far forward to beyond the equator. The spots were intensely black, and when seen two years later they had not changed.

At the first time the boy was seen, he had full visual acuity and he was entirely without other visual symptoms. The second time there were signs of disturbance of the retino-choroid associated with low-grade, uncorrected hyperopic astigmatism. There was an unusual arrangement of the upper vein; the central trunk extended but a short distance on the surface of the quite broad cup, before two main divisions occurred, and then, within the circle of the disk, many drooping twigs were given off to the temporal and nasal regions. The artery came out of the substance of the papilla near the edge of the disk.

The other case was found in the left eye of a young man who had received cerebral concussion during a coasting accident in February, 1914. The vision of his right eye was disturbed by subretinal edema,

which did not subside for several months, and a central scotoma remained.

There were no symptoms in the left, the visual acuity equalling 5/5, and the field was regular in outline but somewhat reduced in area; there were no scotomata, however, and the color-sense was normal and prompt.

Occupying the mid-temporal sector, in the space between the superior and inferior temporal vessels, and extending from the maculo-papillar region to far forwards beyond the equator were groups of chocolate brown and black spots, varying from the minutest sizes to two or three mm., or more, their diameter being less than that of the largest retinal vessels. The smallest spots were in the circum-macular region and the sizes increased until the largest at the extreme periphery. The spots were neither round nor square, but more or less angular and irregular in outline. They were arranged in groups, which assumed various shapes, some circular, or oval, or like a rosette figure with the center free from visible pigment. Finer groups assumed the position of chains of diplococci, others lay isolated. The choroid and retina between the groups and between the spots were normal in appearance, and, as in the previously published cases, the spots here and there covered over the retinal vessels, while the greater number were beneath them. Most of the pigment collections, therefore, appeared to lie deeper than the retinal vessels. The individual spots and the collections were entirely without halos, or areas of degeneration about them. They were, on the contrary, sharply-limited, and each spot and each group of spots had a well-defined outline; neither did the spots coalesce.

The nasal half was entirely devoid of spots, neither were there any other pigment aberrations perceptible.

With Stephenson, Chance does not believe these cases to be instances of retinitis pigmentosa; they are probably congenital. See, also, p. 7634, Vol. X of this *Encyclopedia*.

Retina, Plastic exudation into the. See **Commotio retinæ**, and **Retina, Injuries of the.**

Retina, Plugging of central artery of. See **Retinal arteries, Embolism of the**; also, p. 4287, Vol. VI of this *Encyclopedia*.

Retina, Pseudoglioma of the. CRYPTOGLIOMA. See **Pseudoglioma**; also, p. 3573, Vol. V of this *Encyclopedia*.

A fair example of this condition is reported by C. Velhagen (*Klin. Monatsbl. f. Augenheilk.*, Nov., 1912). An infant presented a yellow reflex behind the lens, which raised the suspicion of glioma retinæ and caused the eye to be removed. Enucleation showed that the appear-

ance was due to a mass of connective tissue behind the lens, which was breaking into the substance of the latter through an opening in the centre of its posterior capsule. It was connected with a persistent hyaloid artery.

The author quotes eight previously recorded cases which in some respects resemble his own. He points out the difficulties in the way of diagnosis, and quite rightly contends that the mistake of removing an eye under such circumstances is much less serious than that of leaving an eye which contains a glioma.

Retina, Pseudo-neuroepithelioma of. See **Pseudoglioma**; as well as **Retina, Pseudoglioma of the.**

Retina, Pulsation of vessels of the. See **Retinal arteries, Pulsation of the.**

Retina, Punctate. See **Retinitis punctata.**

Retina, Ring atrophy of the. Wernicke (*Oph. Year-Book*, p. 246, 1909) reports a case of the ring atrophy of the choroid and retina of Fuchs. The patient suffered from congenital cataract, and had a sister probably similarly affected. The visual fields in pigmentary degeneration of the retina have been studied by Hepburn in 26 cases. He concludes that in primary degeneration of the retina, retinitis pigmentosa, ring scotoma is the first impairment of the field, and afterwards different parts are lost in regular order, the fixation point being last to disappear.

Retina, Rods of the. See **Retinal rods.**

Retina, Rosette figures in the. Berta Lindenfeld (*Klin. Monatsbl. f. Augenheilk.*, April, 1915) describes the findings in two cases. The first, a fetus of five to six months, presented rosette-like collections of cells in the retina in the neighborhood of the optic nerve, and the other, a seven or eight months fetus, showed in the region of the ora serrata a folding of the external nuclear layer of the retina and some small collections of undifferentiated cells. In considering the significance of these changes, the authoress discusses the possibility that they may represent the early stage of retinal glioma, but decides against this supposition. Another possibility is that they were the result of the action of the X-ray treatment, which had been applied to the mothers, in order to produce sterility. See, also, **Retina, Glioma of the.**

Retina, Rupture of the. See **Retina, Injuries of the.**

Retina, Sclerosis of the. See **Retina, Angiosclerosis of the.**

Retina, Separation of the. See **Retina, Detachment of the.**

Retina, Serous exudation into the. See **Retina, Edema of the.**

Retina, Shot-silk. An opalescent effect, as of changeable silk, sometimes seen in the retinas of young persons.

Retina, Snowbank appearance of the. Reference to the snow-white exudate often seen about the disk in albuminuric retinitis.

Retina, Subhyaloid hemorrhage of the. See **Retina, Hemorrhages into the**; also, p. 10353, Vol. XIII of this *Encyclopedia*.

Retina, Syphilis of the. This subject is discussed under **Retinitis syphilitica** and other captions. Here a few examples of retinal lues are given. The *Ophthalmic Year-Book* reviews the following.

The eyes of a boy 2½ years old, dead with many evidences of inherited syphilis, were examined by Ito. The inner layers of the retina showed small cell infiltration. The glial elements diffused through the nerve fiber layer seemed to play an important rôle in the pigmentation found more or less throughout the retina. The pigment epithelium seemed little altered. The walls of the large arteries were thickened, the adventitia with small cell infiltrates, the intima by proliferation; the lumen being narrowed. The larger vessels also showed small cell infiltration of the adventitia. There was severe basilar arteritis. The choroid was greatly changed, being almost a mass of granulation tissue. Ito believes that the retinal lesions were not secondary to vascular changes but directly caused by the spirochete or its toxins.

Igersheimer examined an eye removed for suspected glioma from a child of 6 months suffering from congenital syphilis. Although the choroid was intact there were extreme alterations in the retina, the nerve fiber and ganglion cell layers being most changed. The inflammatory exudates pointed to a retinitis coincident with inflammation of the iris and ciliary body. The child's other eye appeared normal at the time, but later became affected with the usual chorioretinal changes of congenital syphilis.

McKee reports a case where the pigment diffused through the retina was strikingly massed around the vessels which were thickened, with lumen narrowed to obliteration. The changes were much greater in the anterior portion of the retina.

Examining with the ophthalmoscope every infant showing nervous disturbances, Japha has found among 1,350 ophthalmic patients twenty cases of abnormal retinas, in infants with inherited syphilis. Two-thirds of the infants with inherited syphilis show some anomaly of the fundus; which, with the Wassermann reaction, may be the only sign of the disease. Mostly both eyes are affected, but not to an equal extent. By such routine examination the disease can be detected, and the infant placed upon mercurial treatment. He employs two or three fifty-day courses, of 1/2 to 1 cg. of mercury protoiodid

twice daily. After such treatment he saw no recurrences although some of the children remained under observation for years.

A case of exudative syphilitic retinitis is reported by Galezowski. A woman of 25 had suffered iritis ten years before, and failure of vision three years previously; for both of which she received mercurial treatment, but still she gave positive Wassermann reaction. The whole posterior portion of the fundus was occupied by a milky-white, cloudy exudate, which thinned out anteriorly, becoming transparent toward the equator, revealing the classic picture of retinitis pigmentosa, with sclerosis of the choroidal vessels. The changes were more pronounced in the left eye, but of the same general character in both. Vision was reduced in the left eye to light perception, in the outer part of the field.

An example of syphilitic arteritis with optic atrophy is reported by Posey and Krauss (*Ophthalmology,* April, 1908). A. H., a colored woman, 42 years old, came on account of poor sight, from which she had suffered for a year or more. The loss of sight, which had been without pain in the head or eyes, had come on gradually, she thought, after a heat stroke fifteen months previously. A year prior to that, however, she had complained of feeling generally weak. Menstruation ceased one year ago without complications. It was elicited that she had had five brothers and seven sisters. Of these, three brothers and five sisters died in early infancy. The remaining brothers and sisters are generally well. Both father and mother are dead, of unknown cause. The patient was married at 14 years of age, and four years later her husband died of unknown cause. The issue consisted of three children, of whom two are living and well, the other dying when aged 2 years of probable pulmonary trouble.

Upon examination, vision was reduced to counting fingers in the right eye at 12 inches and in the left to 1/lxx. The pupils were 3 mm. in size and reacted rather sluggishly to light and convergence stimuli.

The ophthalmoscope showed an advanced degree of retinal arteritis with secondary atrophic changes in the retina and optic nerve.

The retinal arteries in both eyes are much reduced in size, especially in the neighborhood of each disc, where they appear like mere threads. They are covered with a grayish-white opacity which entirely obscures them at times, and are cord-like and shimmering and resemble silver wires. The veins are but little reduced in size, but are accompanied in places by lateral white lines, which indicate that they, too, have not escaped the vasculitis. Numerous yellowish-white dots in the papillo-maculary region of the retina of both eyes mark the seat of old hemorrhages. In the right eye there is a small round hemorrhage,

not far from the disc, which has appeared since the case has been under observation.

Both optic nerves are in an advanced stage of consecutive atrophy, presenting a dull, chalky-white, filled-in appearance. There are several small, newly-formed corkscrew-like vessels on the head of the right nerve.

The ophthalmoscopic findings are evidently due to an unusually pronounced syphilitic disease of the retina and optic nerve arteries, and resemble in some particulars the changes seen in a case of vasculitis and perivasculitis reported by de Schweinitz at the 1907 meeting of the American Ophthalmological Society. Unlike his case, however, there are no nasal complications, for an examination of the rhinopharynx which was made by Geo. B. Wood showed that region to be free from disease. There are also certain points of resemblance to a case of perivasculitis retinæ reported by C. A. Oliver at the same session. Vessels showing less pronounced changes are depicted in Gowers' and Haab's atlases.

The changes in the blood vessels in this affection may be present a long time without occasioning retinal symptoms. As the process in the retinal vessels occurs as a rule simultaneously with endarteritis obliterans in the cerebral vessels, Schöbl has suggested that the ophthalmoscopic examination is of great semeiotic importance for the general practitioner.

According to the same author, Schelling in 1870 was the first to observe the ophthalmoscopic picture of this affection.

Syphilitic arteritis of the retina must be distinguished from syphilitic perivasculitis, or better, syphilitic periphlebitis of the retina. A case of this affection described by Scheffels occurred in a man 18 years old, the subject of inherited syphilis. Ophthalmoscopically, the optic nerve was hyperemic and the veins were enlarged and tortuous and surrounded by dark, brownish-red hemorrhages. The arteries and retina appeared normal.

According to Parsons, Hutchinson and Bader (1858) made the first histologic examination of vessels diseased by syphilis, and this was followed by Edmunds and Brailey (1880). The latter found thickening of the walls of the vessels and infiltration around them; there was no sign of proliferation. Nettleship (1886) noted increase in the nuclei in the walls of the smaller vessels; the adventitia of the arteries was thickened, sometimes hyaline; the muscular coat was scarcely recognizable, so that arteries could only be distinguished from veins by their greater thickness; there were groups of cells with deeply-stained nuclei in the adventitia and around the vessels. In some

vessels, probably veins, only the inner layers were thickened. Holmes Spicer described similar changes. Uhthoff found infiltration of the adventitia of the veins as well as of the arteries, and the aggregation of cells was sometimes so great that the lumen was invisible. Appel described annular and partial endoarteritis and periarteritis, slight infiltration of the adventitia in the veins and obliteration of many of the capillaries. Bass noted that where the vessels had pigmented around them these were most sclerosed. The obliteration of some of the vessels leads to dilation of the others in the same area.

Retina, Tiger. See **Retina, Leopard.**

Retina, Tigroid. Tiger retina. The striped or spotted retina of ***retinitis pigmentosa***, (q. v.).

Retina, Traumatism of the. See **Retina, Injuries of the.**

Retina, Tuberculosis of the. Retinal tubercle. Few cases of this disease have been reported. In that observed by O'Sullivan and Story a woman, aged 21 years, complained of loss of vision in the right eye. Ophthalmoscopic examination showed an intense papillitis, the swelling being of a brilliant whiteness. Small, white spots were present in the macular region. Two months later vision was reduced to perception of light, pericorneal injection and discoloration of the iris were present, but the tension was normal. The eye was enucleated, and presented a tumor around the optic-nerve head. Microscopic examination showed typical tubercular structure. The tumor was separated from the choroid by a coagulum.—(J. M. B.)

In a marked case reported by Komoto (*Klin. Monats. f. Augenheilk.*, xlix, ii, p. 204, 1912), the right eye of a boy, aged 15 years, had been inflamed for two months. The anterior chamber was shallow and contained blood. Posterior synechiæ were present, and behind the clear lens there were irregular, grey prominences. V.=No p. l. T. full. He had suffered from pleurisy one year before. Pathological examination showed the retina to be completely detached and infiltrated with typical tuberculous tissue from the papilla, which was itself invaded, to the ora serrata. At the ora serrata the choroid was attacked to a moderate extent, elsewhere it was infiltrated, but not with tuberculous tissue. The infiltration in the iris and ciliary body was also non-specific.

Jackson (*Oph. Year-Book*, p. 207, 1917), thinks at least some cases of recurrent vitreous hemorrhage in young people are due to intraocular tuberculosis. In two patients, women, he found the fundus obscured by vitreous opacities; later hemorrhages appeared, white exudates and new vessels; proliferating retinitis. Tuberculin gave focal and general reactions and treatment with it stopped the process

in both cases. In another one of his cases the visible lesions were strikingly connected with blood vessels. Round, gray spots, smaller than the disk, appeared over the larger vessels, but finally disappeared and left the region formerly involved quite normal, giving the impression that each spot represented an exudate involving the vessel walls and adjoining vitreous. Another feature in this case were small white spots in the macula, approaching in appearance those of renal retinitis. They developed gradually and faded away. The lesion showed marked focal reaction to tuberculin.

Retina, Tumors of the. These have mostly been mentioned under **Retina** captions as follows: *Glioma; Perithelioma; Carcinoma; Cysts; Angioma; Angiosarcoma; Granuloma; Angioglioma; Neuroma; Melanoma; Sarcoma.* See, also, **Tumors of the eye.**

Retina, Varix of the. See **Varix of the retina.**

Retineum. That part of the invertebrate eye that functionates as the retina. See **Comparative ophthalmology.**

Retinitis. Retinitis in general. See, also, corresponding **Retina** rubrics, e. g. **Retina, Suppuration of the,** in connection with **Retinitis, Suppurative; Retina, Syphilis of the,** as part of the study of **Retinitis, Syphilitic,** etc.

The subject of *retinitis in general* (and of the chief forms, *simple edematous* and the *parenchymatous*) need not occupy much of our time, chiefly because the various retinitic alterations known as "retinitis" have really few factors in common; hence it is thought desirable to consider them *seriatim*, in alphabetical order and under separate captions. It may be said, however, that the disease may be primary or secondary and is the result of many causes, most of them general in character. These latter have given rise to the useful designations, *diabetic, syphilitic, renal, hemorrhagic, albuminuric, leukemic, metastatic, tuberculous*, etc.

The treatment of most of these clinical forms will be considered separately. In all cases complete rest of the eyes, tinted glasses, leeches and cold fomentations to the forehead and temples will be found useful. In addition Turkish baths, pilocarpin sweats with iodides, salicylates and mercurials are most commonly employed. The best manner of administering these remedial agents is considered elsewhere in this *Encyclopedia.*

In studying the various forms of retinitis it must be borne in mind that most retinitic processes are combined with changes in the underlying choroid. See discussion of this point under **Choroiditis, Syphilitic,** p. 2158, Vol. III of this *Encyclopedia.*

R. Foster Moore *(Quart. Journ. of Medicine*, Vol. X, 37-38, 1916-

1917) believes that there is a *simple or local retinitis* and adduces much clinical evidence in support of this view. He says that this form of retinitis is associated with severe general arterio-sclerosis; that it is caused by a local retinal vascular disease; and that its association with disease of the kidney is only incidental. He also thinks that the retinitis is in large measure distinct from renal retinitis in its ophthalmoscopic characters, in its significance, and in its prognostic value; that it is always associated with severe arterio-sclerosis and retinal vascular disease; that its gradual evolution from a condition of retinal arterio-sclerosis can be traced; that the ophthalmoscopic appearances are in a large measure distinctive. It is frequently unilateral, and "cotton-wool" patches never occur. The tenure of life of the subjects of this condition is very uncertain, but they often live a number of years. The cause of death is referable to disease of the vascular system and not to disease of the kidney.

Mooore also finds that the relation between the condition of the retinal arteries and that of the arteries of the brain is striking and conclusive; for of 44 patients suffering from a gross cerebral vascular lesion 31 (70 per cent.) exhibited evidence of retinal vascular disease, and in 19 of them (43 per cent.) it was severe in degree.

The cause of death of the patients studied was ascertained in 26 instances. Of these 26 cases a gross vascular cerebral lesion was the cause of death in 12 (46 per cent.).

Of the patients in whom retinal vascular disease was sufficiently severe to give rise to symptoms, in 46 there was satisfactory information as to the development or otherwise of gross cerebral lesions. Of these 46 patients 21 (46 per cent.) had either suffered from such a lesion or developed one in the course of about three years. See **Retinitis, Renal.**

Samuel West (*Lancet*, Feb. 12, 1916; abstract in the *Ophthalmoscope*, p. 376, 1916) thinks Foster Moore (see preceding abstract) has not clearly differentiated chronic nephritis and renal nephritis. The former is sometimes employed to include both kinds of chronic nephritis and confuses two distinct conditions, viz.: parenchymatous nephritis and granular kidney. Albuminuric retinitis also exists in two forms, which should be distinguished from one another. These West calls exudative and degenerative forms and says they differ in their ophthalmoscopic appearances, their pathology and their clinical significance. The exudative form corresponds to what is generally known as acute optic neuritis and the choked disk of a cerebral tumor. It may occur with acute or chronic parenchymatous nephritis, and disappears if the patient recovers from the nephritis. It may also occur in gran-

ular kidney in the terminal stage when the end is near. The degenerative form presents the glistening white patches which are so characteristic of albuminuric retinitis. It is pathognomonic of granular kidney. It may in the later stages of granular kidney have grafted on it, or added to it, the exudative form, but the two forms are even then independent of one another. The statements made about albuminurie retinitis in books are hopelessly contradictory; and this is not surprising, for with two forms of chronic nephritis distinct from one another, and two forms of albuminuric retinitis, also distinct from one another, there is plenty of room for divergence or contradiction if the distinctions are not made and not clearly observed. The two terms which lead to all this confusion are chronic nephritis and albuminurie retinitis. If these are properly defined and the distinctions strictly observed, all the apparent contradictions can be reconciled. Regarding Foster Moore's observations it is clear, says West (1) that all the cases he deals with are acute nephritis. Even what he calls chronic nephritis is merely acute nephritis which has lasted somewhat longer than the others; and the pathological condition is that of chronic parenchymatous nephritis or the large white kidney. (2) That the form of albuminuric retinitis met with in his cases is of the exudative type. Thus defined Foster Moore's paper has a greater value than he claims for it. It shows, first, that albuminuric retinitis in one of its forms occurs in acute nephritis, on which he expressed a somewhat uncertain opinion. There can be no doubt of the fact. West has seen many instances of it himself. West concludes as follows: "(1) Albuminuric retinitis may occur and is not rare in acute nephritis. (2) It is of the exudative type. (3) It is an indication of the severity of the case, and although more likely to be found in cases of some duration, it may be present quite early if the case be severe, or remain absent throughout if the case be mild. (4) In any case, if the nephritis resolve it may completely disappear and leave no defect of vision behind. (5) The statement that it is toxic in origin is probably correct. Foster Moore's observations are a distinct contribution to the subject, and so far as acute nephritis is concerned, confirm the views I expressed definitely in my Lettsonian lectures of 1900."

Retinitis, Albuminuric. Retinitis of Bright's disease. Diabetic retinitis. Leukemic retinitis. Retinitis gravidarum. Hemorrhagic retinitis. Gouty retinitis. Circinate retinitis. Retinitis of pregnancy. In addition to the matter furnished on pp. 207 and 212, Vol. I; p. 9043, Vol. XII and under **Pregnancy,** p. 10335, Vol. XIII of this *Encyclopedia* the reader is referred to **Bright's disease,** p. 1296, Vol. II and to **Retinitis, Renal** and other **Retinitis** captions.

In 1827 Bright called attention to the loss of vision accompanying renal diseases; in 1856 the retinal changes were first observed in the living eye by Heymann; and in 1859 Leibrich gave an accurate description and an ophthalmoscopic picture of the fundus changes of albuminuric retinitis.

Of 935 cases of kidney disease, tabulated by Groenouw and Uhthoff, albuminuric retinitis was present in 209, or 22.4 per cent.; Wagner met it in 6 per cent. of his cases, while in Galezowski's cases 31 per cent. showed albuminuric retinitis. While the disease has been observed a few times in children, as a rule the patients are over 40 years of age, and the majority are between 40 and 50 years old. Men are more frequently affected than women in the proportion of about 7 to 3. As regards the form of kidney lesion present in albuminuric retinitis, the small contracted kidney is the most frequent; chronic diffuse parenchymatous nephritis (large white kidney) forms a close second; the nephritis of scarlatina is third; and the least frequent are the rare cases of amyloid degeneration. As a rule, both eyes are involved in the retinal changes, and it rarely happens that the second eye remains entirely well for the period of a year.

According to Porter, in the majority of cases of renal disease there is no disease of the retina; and a majority of renal cases showing retinal changes also show changes in the blood-vessels. He concludes that the eye disease does not depend so much on the existence of the renal affection as on the fact that the blood-vessels are diseased.

The ophthalmoscopic changes in the disease are described on p. 9043, Vol. XII of this *Encyclopedia*.

In some cases papillitis occurs either in the beginning of the ocular disease or long after the appearance of the retinal changes. In these cases probably there is often a coexistent brain-lesion with increased intracranial pressure, and a fatal result is to be expected. Papillitis, however, can occur in albuminuric retinitis without brain-lesion.

If, as is often the case, the preliminary stage of hyperemia is absent or is not observed, glittering white patches form the first sign in the retina. They are often arranged in groups surrounding the papilla like a ring and coalescing form large white spots. The inexperienced observer may mistake this condition for opaque nerve-fibres in the retina. Both present large white plaques passing from the papilla, but in the congenital condition (opaque nerve-fibres) signs of inflammation are absent. The exudation of a recent choroiditis is to be distinguished from albuminuric retinitis by the less brilliant whiteness of the patches, and by the fact that they are accompanied by vitreous opacities and pigment collections, while hemorrhages are absent. In

the macular region the white spots frequently form a stellate figure. Hemorrhages are found in great variations. In some rare instances the retinal change is present as a retinitis hemorrhagica, and the white spots are either entirely absent or are present in small numbers. In other rare cases the spots are found in the choroid as well as in the retina, and pigmentation is present. These are cases of primary inflammation of the uveal tract. The frequency of involvement of different portions of the retina has been estimated by Schlesinger. He found hemorrhages and typical lesions in 77 per cent. of all cases of albuminuric retinitis, white spots alone in 14 per cent., and involvement of the papilla alone in 7 per cent. The ophthalmoscopic picture is thoroughly typical when both the disseminated white spots and the stellate figure at the macula are present, but an exactly similar picture is sometimes seen, together with papillitis, in some cases of sarcoma of the brain without kidney-lesions. According to Laqueur, the same is true of some cases of diabetes mellitus, and also of patients whose urine never contained albumin. A similar picture may be found in poisoning, anemia and syphilis. The white stellate figure at the macula is not always characteristic of kidney-lesion. On the one hand, it may be absent in albuminuric retinitis, and, on the other, it is sometimes seen in cases where albumin is never present in the urine.

The *visual disturbances* of this disease comprise a greater or less loss of visual acuity, without, as a rule, contraction of the field of vision and without loss of the color- and light-senses. Central scotoma is often present. The loss of vision is usually slow, rarely rapid, complete blindnes being seldom observed. If it suddenly occurs in both eyes, it is suggestive of uremic amaurosis; if unilateral blindness or great loss of vision occurs rapidly, the case is likely one of embolism of the central retinal artery.

Albuminuric retinitis may show improvement or even complete cure, but many patients die before the retinal disease undergoes retrogressive changes. If the kidney-lesion improves, the surgeon may hope for improvement in the ocular condition. In some cases the retina improves regardless of the extension of the renal affection. Retinal improvement, when it occurs, is slow, and the stellate appearance of the macula is the last to disappear. The optic-nerve head may become whitish and atrophic and useful vision may remain. Some cases show alternating loss and improvement of vision for a long period. Complete blindness as a result of this disease is extremely rare. Complications are not common, and include detachment of the retina, hemorrhage of the vitreous humor, hemorrhagic glaucoma, and embolism of the central retinal artery.

The *anatomic changes in albuminuric retinitis* are found chiefly in the posterior pole, rarely reaching forward as far as the equator, and never involving the ora serrata. They consist of edema and inflammatory deposits. The edema accounts for the diffuse cloudiness which is visible ophthalmoscopically. The blood-vessels, not only of the retina, but also of the uveal tract, frequently show sclerotic or hyalin changes in their walls. The radial fibres of Müller undergo proliferation, and their interstices are filled with a fibrinous deposit. In the retinitis albuminurica of pregnancy changes in the retinal vessels are occasionally absent (Silex).

Hemorrhages occur into the retina and at times break through into the vitreous humor. The white spots, which are visible with the ophthalmoscope, depend on granular or fatty degeneration of the supporting tissue; upon fatty degeneration of cells, particularly in the two granular layers; or upon the presence of foci of varicose hypertrophied nerve-fibres. The stellate figure in the macular region depends chiefly upon fatty degeneration of Müller's supporting fibres, which radiate from the fovea centralis, and here do not, as in other places, push through the retina. Weeks questions this explanation. His researches lead him to believe that the changes in Müller's fibres are due to postmortem alterations. The choroid on microscopic examination shows similar changes, viz., lesions of the vessels and inflammatory changes.

In the optic nerve, together with hypertrophy of the connective tissue, there is edema or pronounced inflammation. Generally the inflammatory changes involve only the papilla and end at the lamina cribrosa, without further extension centrally. Gurwitsch found hyalin bodies in the head of the optic nerve and in the granular layer of the retina.

The cause of retinal detachment in albuminuric retinitis is explained by Leber and Nordensen in this manner; the small elevations, especially around the papilla, depend on a primary exudation into the subretinal space, while further detachment can be attributed to shrinking of the vitreous humor.

In typical cases the *diagnosis* of albuminuric retinitis is not difficult, but it must be remembered that, while the ophthalmoscopic picture is highly suggestive, it is not pathognomonic, similar fundus changes being met with in rare instances in cases of intracranial tumor, lead encephalopathy, pachymeningitis hemorrhagica, anemia, syphilis, and diabetes mellitus.

Tumor of the brain, as a rule, is easily distinguishable from Bright's disease. However, in some cases of cirrhotic kidney there is little or

no dropsy, headache or vomiting are often prominent and distressing symptoms, and pain may be most severe in the back of the head; epileptiform convulsions and even hemiplegia may be present, while the ophthalmoscopic changes may be similar to those found in cerebral tumor.

In the differential diagnosis it will be necessary to give attention to the following points: 1. The condition of the urine. While the finding of albumin and tube-casts will clear the diagnosis, in some cases of cirrhotic nephritis albumin may be scanty or entirely absent and tube-casts may be so few as to escape detection. 2. Condition of the heart and great vessels. In all forms of Bright's disease, except possibly in the pure form of waxy kidney, the blood-pressure is high, the arteries are atheromatous, and the left ventricle is hypertrophied. In the absence of a valvular lesion these symptoms are highly suggestive of renal disease. 3. Ophthalmoscopic changes. "The ophthalmoscopic changes, *per se*, can never be taken as an absolutely certain guide, for the appearances typical of one condition are, in some rare and exceptional cases, met with in the other." (Bramwell.)

Saturnine retinitis. While in most cases of chronic lead-poisoning (which may present ophthalmoscopic changes similar to those of albuminuric retinitis) albuminuria is present, exceptional cases have been observed by Förster and Lehmann. The diagnosis between albuminuric and saturnine retinitis must rest on the following data: (1) the history of the case with special reference to the patient's occupation; (2) the presence of a blue line on the gums in case of lead poisoning; (3) the finding of lead in the urine.

Anemia and syphilis. In cases of these diseases presenting ophthalmoscopic appearances similar to those found in albuminuric retinitis, the diagnosis may be established by an examination of the blood in one and by the history and lesions of the other.

The ophthalmoscope cannot always make a distinction between albuminuric retinitis and the retinitis associated with diabetes. Here an examination of the urine will give correct information. Cases of hysteric blindness occurring during the puerperium, especially if a trace of albumin is present, may cause difficulty in diagnosis. Here, however, there will be an absence of ophthalmoscopic changes. In all cases of suspected albuminuric retinitis repeated examinations of the urine should be made for albumin and casts. In case a mydriatic is used to facilitate the ophthalmoscopic examination, the surgeon should use euphthalmin or homatropin, since their effect lasts only a short time. If atropin is used and the patient suffers further diminution of

vision from progression of the disease, the surgeon may be unjustly blamed for the loss of sight.

Albuminuric retinitis is an indication of a serious underlying condition, and its appearance usually foretells the early death of the patient. The prognosis is most unfavorable in chronic nephritis; it is more favorable in acute nephritis and relatively most favorable in the albuminuria of pregnancy. Probably 85 per cent. of all persons with albuminuric retinitis die within two years. A few live for three, four, five or six years, and exceptional cases have survived for ten or twelve years. The social status and hygienic surroundings have an influence on the duration of these cases, the poor dying sooner than the wealthy.

The *retinitis albuminurica of pregnancy* presents many peculiarities, on which account it must be considered alone. Comprehensive descriptions of this disease have been given by Axenfeld and Silex. The latter observed thirty-five cases in seven years. In this disease the loss of vision appears slowly in the course of weeks and months, and chiefly in primiparæ and in the latter half of pregnancy. Exceptionally the retinitis may appear first in childbed. Visual acuity diminishes gradually in both eyes without contraction of the visual field, and without loss of the color-sense. Sometimes complete amaurosis occurs, particularly if eclamptic seizures accompany the disease. This blindness is traceable to uremia, and usually disappears. It is only when complications occur, such as detachment of the retina, that vision can be completely lost. In subsequent pregnancies mild recurrences are the rule, by each of which a further loss results. Disturbance of the general health may be absent; only edema is present.

See p. **Pregnancy, Ocular disturbances in,** p. 10337, Vol. XIII of this *Encyclopedia.*

The ophthalmoscopic signs are the same as those found in albuminuric retinitis from other causes. As an early symptom Silex mentions a change in the central reflex streak of the arteries, which, in the upright image, appears broadened and of a glistening golden yellow. Yet this phenomenon, as Silex especially states, is found also in syphilis and in arterio-sclerosis, and hence is not characteristic of the albuminuric retinitis of pregnancy. The changes in the vascular reflex are attributed to an engorgement in the lymph-sheaths of the blood-vessels.

Retinitis gravidarum appears, according to Groenouw:—

1. In the pregnancy kidney, in which there is fatty degeneration of the epithelium of the uriniferous tubules. The urine in these cases is passed in diminished quantity and is of dark color. It is strongly albuminous, showing hyalin, rarely granular, casts, with fatty degenera-

tion of the epithelial cells. The disease occurs in from 1 to 20 per cent. Retinitis albuminurica, according to Silex, occurs about once in three thousand pregnancies. Thompson found, among thirty cases of retinitis albuminurica observed by himself, four that were due to pregnancy.

2. If an acute nephritis accidentally originates during pregnancy, or, finally,

3. If an old chronic nephritis becomes unfavorably influenced by pregnancy. In the two examples last named, pregnancy is not the cause, but is only a complication, of the kidney affection. The pathologico-anatomic findings in the albuminuric retinitis of pregnancy are the same as those found in other instances, only involvement of the vessels is either entirely absent or is insignificant.

The *prognosis* as regards life and vision in cases of albuminuria is most grave when a chronic nephritis exists, since most of these patients die within two years; it is better in acute nephritis, since complete cure of the eye and kidney symptoms may occur; and is most favorable in pregnancy kidney (albuminuria due to pressure). Of twenty-one cases of retinitis gravidarum, Silex saw a complete disappearance of the retinal changes in two cases; the other cases presented permanent retinal changes either in the form of small white spots or as pigment degeneration in the macular region. Persistent loss of vision points to a complication, such as retinal detachment or atrophy of the optic nerve. Partial atrophy of the optic nerve was observed by Förster in three of four women with retinitis gravidarum who were delivered during eclampsia.

If, however, premature labor is induced, the prognosis is much more favorable as regards vision. Without the induction of premature labor the prognosis is most serious. Howe, in an analysis of cases extending over a period of fifteen years, says: "These tend to show that, when the vision begins to be impaired only in the last two weeks of pregnancy, recovery follows almost invariably. Of those described as being in the eighth month or thereabouts, when the retinitis commences, not one-half recovered, and several did not materially improve. Again, when this began earlier than was estimated—as the middle of the seventh month, when Nature did not interfere by bringing on a miscarriage, and when the patient escaped with her life—it was only to remain blind forever afterward."

The *treatment of retinitis albuminurica* must be governed by the fundamental disease. Sudorific and purgative treatment will be in order. A long-continued use of potassium iodid, citric acid, and similar remedies has proved of value. The diet should be nutritious but

non-stimulating, milk diet being preferred. The patient's strength should be kept up by preparations of iron. If the cause of the kidney lesion can be determined—such as malaria, syphilis, or lead poisoning—it should receive appropriate treatment. The use of mercurials, however, must be carefully watched lest harm result. Cupping may be used, but is of doubtful value. The use of alcohol, coffee, tea and tobacco is to be interdicted. To improve the retinal circulation efforts to reduce intra-ocular tension by means of instillations of 1-per-cent. strength solution of pilocarpin or ½-per-cent. solution of eserin may be tried.

The albuminuria of pregnancy demands careful attention from the family physician. The question whether premature labor should be induced should receive careful consideration. Many surgeons believe that where there is progressive failure of vision from retinal changes premature labor is justifiable; and, when a preceding pregnancy has left the patient with permanent loss of vision, abortion should be produced.—(J. M. B.)

What may be termed the "French view" of this subject is expressed in a symposium of the Ophthalmological Society of France in which Rochon-Duvigneaud (*Archives d'Ophtal*, May, 1912; review by Lawford in the *Oph. Review*, Oct., 1912) opened the discussion. The report is in two parts: Retinitis of pregnancy; Albuminuric retinitis.

(1) *Retinitis of pregnancy.* The writer deals only with cases in which pregnancy is the sole etiological factor, but he groups with these, cases of so-called optic neuritis of pregnancy, believing that their etiology and evolution do not differ materially from those of true retinitis.

Gravidic retinitis is much less frequent, once in 3,700 pregnancies, whereas retinitis is found once in 45 cases of albuminuria. It is most frequent among primiparæ and seven-tenths of the cases occur during the last four months of pregnancy.

Retinitis may develop in association with the forms of eclampsia which have a rapid onset and which, when severe, kill like active poisons, the autopsy showing recent lesions of the liver and kidneys. Most commonly the retinal changes develop in the course of a subacute eclampsia, caused by a less active intoxication.

What is the cause of a retinitis so similar to that of nephritis? It seems probable that there is a nephritis of pregnancy, occasioned by toxemia; a nephritis which in the majority of cases is transitory, but in some instances persistent and inducing progressive changes in the kidneys.

Is this nephritis the cause of the retinitis? All the evidence is in favor of this view.

The amaurosis of eclampsia not infrequently follows upon visual defect already caused by retinal lesions. In 154 cases of gravidic retinitis, amaurosis was noted in 17.

The relation between amaurosis and lesions of the fundus oculi is obscure and it is open to question if the distinction between the two classes of cases is as great as is commonly believed. A sudden toxic saturation of the optic nerve or of the retina may be able to determine an amaurosis which is without visible lesions only because such lesions have not had time to develop.

This hypothesis accords with the cases of uremic amaurosis followed by optic atrophy of which examples are not very rare.

The pupillary light reflex is retained in 3/5 of the cases of gravidic amaurosis and is lost in 2/5. Retention of the light reflex is a favorable sign, while its absence increases the gravity of the prognosis.

The ophthalmoscope may reveal changes which range from a very slight retinitis to one of great intensity with papillitis and abundant hemorrhage and white exudation. It is not unusual to find white patches without hemorrhage in the retina. The "macula star" appearance is not a constant phenomenon.

Detachment of the retina is more common in the retinitis of pregnancy than in other forms. As a rule it is not of long duration and disappears in a few days after delivery.

It is exceptional for any amelioration of the retinal lesions to occur during the continuance of pregnancy; the sight progressively fails until the time of delivery. The death of the fetus may be followed by disappearance of the amblyopia and of the retinitis. Potocki and Perrien have recorded such a case.

In spite of a few instances of post-partum retinitis, it is certain that the accouchement arrests the progress of the retinitis, as it does that of the other manifestations of the toxemia of pregnancy.

The characteristics of the retinitis of pregnancy, even in the exceptional cases of retarded retinitis, is the recovery, complete or incomplete, of the ocular lesions, concomitantly with the cessation of its cause. Persistence of the retinal lesions is unusual.

In two classes of cases only are the results definite and well known: these are the cases which terminate fatally and those in which blindness from optic nerve atrophy supervenes.

Prolongation of pregnancy to its natural limit constitutes the greatest danger (8 deaths in 53 deliveries at term); spontaneous premature delivery is less fatal (4 deaths in 34 cases); artificial induction

of labor gives the best results (3 deaths in 68 cases). The prognosis as to vision runs parallel to that of life, in each of these groups.

Histological examination of the retinitis of pregnancy has been but rarely made. Two such examinations are reported; one by Cirincione, and one by Lauber and Adamuk. The lesions appear to be identical with those of ordinary albuminuric retinitis; the most common feature are areas of sero-fibrinous exudation, and foci of degeneration in the ganglion and nerve fibre layers. The condition of the vessels varies greatly.

As stated above, an artificial termination of pregnancy offers the best results as to life and also as to the woman's sight. The best possible chance of restoration of normal acuity of vision is by termination of pregnancy at the earliest possible date after the onset of retinitis or of amaurosis.

A more difficult problem is that of future pregnancies. The author believes that any serious diminution of vision as a result of the retinitis renders the prognosis extremely grave if the patient again becomes pregnant. He also states that in case of good recovery a period of at least two years should elapse before the risk of pregnancy is again permitted.

(2) *Albuminuric retinitis.* The onset of retinitis is often the first clinical evidence of a condition of azotemia, and constitutes a definite complication and aggravation of a nephritis which until the date of development of the retinal lesions had been well tolerated. The arterial tension in nephritis *without* retinitis is always considerably raised in the aged, less so in middle-aged and young people; in nephritis *with* retinitis the tension is always much raised, whatever age the disease appears.

If the rare cases of retinitis during acute or subacute nephritis ending in recovery be eliminated, a more or less rapid course to a fatal termination is the rule.

The ophthalmoscopic characteristics are in a general way fairly regular and constant, but minor variations are common, even in cases in which the renal changes are similar. The general rule is that a zone of retina is infiltrated with whitish patches and hemorrhages, around a papilla more or less swollen and edematous. The equatorial and peripheral parts of the retina retain their integrity. The retinal lesions are not in themselves pathognomonic.

Albuminuric or nephritic retinitis may be defined as an exudative and hemorrhagic retinitis, associated with an advanced degree of renal insufficiency, and which develops at the beginning or during the course of the uremic condition.

In addition to the swelling of the papilla, the surrounding retina is thickened, and this peripapillary thickening distinguishes this form of papillitis from that due to intracranial tumor. The lesions stop at the cribriform lamina; the optic nerve shows no changes, except in cases of subsequent atrophy.

The vascular lesions are inconstant, and this alone proves that they are not essential to the development of the retinitis. If they play a part in the lesions of the retinal tissue, it is certainly a secondary rôle. The preponderating lesions are fibrinous and cellular exudations, the former being more constantly present.

The blood-vessels of the choroid may be more affected than those of the retina, but blood extravasation in the choroid is much less frequent. There is justification for the term albuminuric choroido-retinitis, which has been proposed by some writers.

Researches into the chemistry of albuminuric retinitis have not yet led to any certain results.

Rochon-Duvigneaud believes it unnecessary to consider a general arterial degeneration as the intermediary between the disease of the kidneys and the ocular lesions. Nephritis and retinitis are not two associate lesions, dependent upon a common cause, acting individually upon the kidney and the retina. The retinitis is ''subordinate'' to the nephritis, and is to be considered as a local phenomenon, in patients in whom the only constant lesions are renal mischief and cardiac hypertrophy.

The diseased kidney is the cause of the retinal lesions, not by reason of any particular type of organ, *e. g.*, the contracted granular kidney, but in consequence of deficient elimination, and the retention of urea or of some substance intimately related to urea.

Souter (*Oph. Review*, p. 91, Apr., 1916) gives an interesting review of Jacques Mawas' article (*Annales d'Oculistique*, 153, Feb., 1916) on the *histo-chemistry of the white patches in albuminuric retinitis.* The writer believes that they are due to four different kinds of lesion —exudates in the intergranular layer, gangliform degeneration of nerve fibre layer, massing of granular cells, detachment of the limitans interna of the retina. He also thinks that gangliform degeneration of the optic nerve fibres is a rare affection, not typical of albuminuric retinitis; so is detachment of the limitans interna. He feels certain that the exudates of the intergranular layer are typical of the disease; that these exudations form the macular star, the rays and the great majority of the white patches; that there does not exist any trace of fat or of lipoid in any of the three lesions cited, *i. e.*, exudates, detachment and gangliform degeneration, nor any deposit whatever of crys-

tals of cholesterin or of fatty acid; that the exudates arise and end up by disappearing, eaten up by the phagocytic granular cells, the massing of which can give rise to the white patches—the last stage of the period of regression of the disease; that the granular cells are identical with the granular bodies of the central nervous system, these cells being endowed with the power of phagocytosis and containing in their protoplasm the lipoid droplets, staining with osmic acid and Sudan iii; that the presence of the granular cells is essentially transitory; that the retinal white patch, whatever be the lesion giving rise to it, cannot be considered as a deposit of cholesterin of vascular origin—hypercholesterinaemia—for at no stage of its evolution can the presence of cholesterin or of ethers of cholesterin be established.

The technique employed began as soon as possible after death by the injection into the vitreous of some drops of pure formol to arrest the autolysis of the retina and to keep up the intraocular tension. The fixation was done by formol 10 per cent., formol bichromate 20 per cent., Zenker's fluid or that of Tellyesniczki, in each case finishing up with some days in 3 per cent. potassium bichromate. Embedding was done in celloidin, and the staining usually hematein, followed by rubine S. and orange G. The study of the lipoids and fats was made by one or other of two proceedings. A consisted of fixation in 10 per cent. formol for 24 hours; insolubilization and oxidation of the fats and lipoids by potassium bichromate 3 per cent. with a few drops of acetic acid for 48 hours at least; washing in running water for 24 hours, dehydration by successive alcohols; embedding in celloidin; staining with hemalum, Sudan iii in saturated alcoholic solution; mounting in glycerin or the sugar medium of Apathy-Renaut. In this way the sections were regular and easily manipulated, while the lipoids preserved themselves well and stained a red orange deeply, showing up against the uncolored ground of the preparation beside the nuclei stained violet. Proceeding B consisted of fixation in formol 10 per cent. for 24 hours or formol bichromate 20 per cent. for 24 hours; washing in running water for 24 hours; 2 per cent. aqueous solution of osmic acid for 24 hours; washing in running water for 24 hours; embedding in celloidin. This method allows the fats and lipoids to be studied in thin sections which are not friable, even after embedding in paraffin. The usual stains—hemalum-eosin, hematein, picro-carmine, hematoxylin and Sudan iii—do well even after prolonged action of bichromate and of osmic acid. Bleaching was done by 12-24 hours in a 2 per cent. solution of chromic acid without the sections becoming altered or friable.

Mawas agrees with Rochon-Duvigneaud that the vascular lesions

are but a terminal stage of the disease and not an essential feature, being often quite absent. The exudates are situated in the intergranular and external granular layers, are homogeneous or slightly fibrillary and stain with eosin and rubine S. The exudate may be fibrin or some complex albuminoid substance arising from destruction, perhaps by hemorrhage, of the nervous elements at this level—a sort of miniature softening—it is difficult to say. These exudates are the cause of the yellowish-white aspect of the white patches in the retina. These exudates are found in the early stages of the disease while the granular cells do not appear till long after, when they act as macrophages. These cells are large, rounded or oval, with a vacuolar protoplasm often having a deformed, compressed nucleus; the vacuoles appear to be empty of contents, *i. e.*, with ordinary preparation, but with the special technique employed they are seen to contain drops of fatty nature, more exactly drops of lipoid. In the white patches formed by the detachment of the limitans interna, undermined by considerable exudation, in those due to gangliform degeneration and in those, infinitely more frequent, due to the so-called fibrinous exudates, Mawas had not been able to find any fat substance whatever—only the granular cells containing the lipoid droplets. These stain a yellow-orange with Sudan iii, grey with osmic acid, and black as Chinese ink with osmic acid after previous oxidation by formol or chromic acid and its salts and are extremely soluble in alcohols and fat solvents such as ether, xylol and toluene. In no case had Mawas found the retinal white patch to be a lipoid plaque of cholesterin in nature, understanding by these expressions a deposit of cholesterin in the retina. And in this connection he states that the specimen founded on by Chauffard, Guy-Laroche and de Font-Réaux was one obtained several days after death, when the cadaver was in quite an advanced state of putrefaction.

The presence of the granular cells does not constitute a lesion but is merely a transitory phase of a phagocytic order in the process of disintegration of the exudative masses.

Retinitis antica. (L.) Retinitis in which there is inflammation of the inner retinal layer.

Retinitis apoplectica. Retinitis accompanied by hemorrhages; hemorrhagic retinitis.

Retinitis atrophicans centralis. See **Retinitis centralis atrophicans.**

Retinitis, Bright's. See **Retinitis, Renal**; as well as **Retinitis, Albuminuric.**

Retinitis cachectica. Retinitis cachecticorum. Inflammation of the retina the result of cachectic conditions.

Nakaizumi (*Oph. Year-Book,* p. 244, 1912) reports a case in which the ophthalmoscopic examination, two days before death from cancer with extreme cachexia, showed pallor of the fundus, disk and vessels, a few small hemorrhages, and numerous glistening white specks around the disk. From his microscopic study of the retina he concludes that the condition essentially resembles the retinitis of other pernicious anemias, and that it is not inflammatory, but degenerative. The white appearances are due to varicose swelling of nerve fibres and the presence of fatty substances. The glittering appearance of the retina marks the onset of fatty infiltration; the substances belong with cholesterin and the phosphatides. They appear in the last stage of cachexia, when perhaps a state of lipemia may have arisen. Moore saw a man of 41 suffering extreme anemia from bleeding piles, whose vision was, R. fingers at one foot, L. 3/60. His retinal vessels and optic disks were very pale. Operation for piles stopped the bleeding, and his general condition improved greatly. But vision remained unchanged.

Retinitis, Central. In addition to what is stated on p. 1959, Vol. III of this *Encyclopedia,* it may be said that tissue alterations of the macular region are quite common in many forms of retinal disease. When they are more or less constant or form a principal sign of a process apparently inflammatory they are designated "central" retinitis. In this category might be included all those intraocular diseases that involve in particular the yellow spot—luetic processes, for example. Myopic macula, sometimes called Fuchs' disease (see p. 7575, Vol. X), Batten's disease (p. 7576, Vol. X of this *Encyclopedia*) and other congenital or acquired changes at the fovea (causing more or less marked central scotomata) are all classed under this heading. See the rubrics immediately following this caption, as well as p. 5841, Vol. VIII, where Leber's disease (*hereditary central retinitis*) is fully discussed.

Retinitis centralis atrophicans. CENTRAL TRAUMATIC RETINITIS (HAAB). RETINITIS CENTRALIS RAREFICANS.

This rather rare disease has been described both by Haab and Kuhnt (*Zeitschr. f. Augenheilk.,* III, pp. 105 and 113). It occurs as a macular change in the form of a central, circular or oval, sharply-defined spot, one-half to one-third of a disc diameter in size. The foveal reflex is wanting and on close inspection minute, white, shiny dots are seen within the red area which, in some cases, is covered by a very thin tissue network. There is a difference of 0.75—1. D. in the refraction between the centre of the red spot and the circumpapillary retina. The red area is itself surrounded by a fainter, grayish-yellow zone also

beset by a more or less visible collection of whitish dots.

As a rule there is an absolute central scotoma. According to Haab, this condition is due to an actual rent in the macular region due to blunt injury of the eyeball. Of twelve cases seen by him nine were certainly traumatic. Some of these cases showed other evidences of ocular injury, such as retinal and vitreous hemorrhages, choroidal rupture, etc.

Retinitis centralis punctata diabetica. This is one of the (milder) forms of diabetic retinitis in which the ophthalmoscope shows whitish spots—mostly pin-head in appearance and in which hemorrhages are rare. See **Retinitis, Diabetic.**

Retinitis centralis rareficans. A synonym of retinitis centralis atrophicans.

Retinitis centralis recurrens. See **Retinitis, central, relapsing, syphilitic.**

Retinitis centralis serosa acuta. This is the name applied by Wolff (*Zeitschr. f. Aug.*, Vol. 5, p. 272) to a condition which he claims to have discovered by means of his electric ophthalmoscope. It consists of a swelling at the fovea as evidenced by a change in the reflex and may be produced by glaring (see **Retinitis, Solar**). In addition to this central retinal change an iritis or even a central choroiditis may be seen. In the latter instance dust-like opacities may appear in the vitreous in front of the affected macular region.

Retinitis, Central relapsing, syphilitic. RETINITIS CENTRALIS RECURRENS. SYPHILITIC RECURRING RETINITIS. This rare form of syphilitic retinitis of one or both eyes is characterized by the sudden appearance of a central scotoma, which disappears in a few days, only to return with renewed force in a few weeks or months. The attacks increase in length, and the free intervals diminish. Ophthalmoscopically, there is a fine opacity at the macula, of a grayish color, with occasionally whitish dots, isolated or in groups.

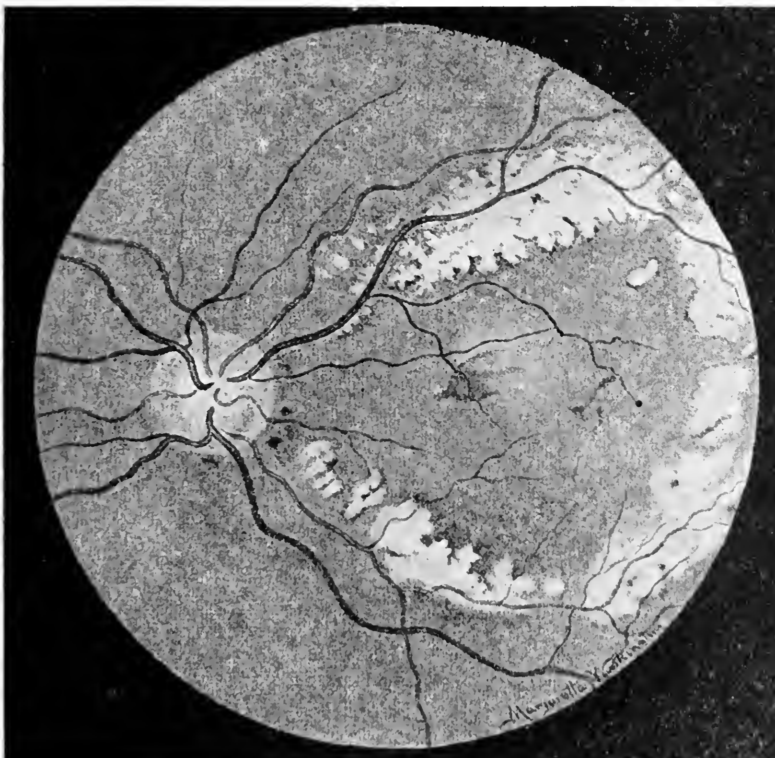
Fuchs (*Ophthal. Year-Book,* p. 215, 1916) adds a case report to the very meager literature on central relapsing syphilitic retinitis, the disease first described by v. Graefe (Graefe-Saemisch *Handbuch,* Vol. VII, p. 732). The patient acquired lues at age of 17, never having any manifestations until 36 years old, when he first noticed a disturbance of vision in the right eye which passed away after a few weeks. Subsequently the disturbance relapsed more and more frequently, and finally became permanent. The subjective symptoms were a slight diminution of the central vision and the presence of a positive scotoma. With the ophthalmoscope faint clouding of the retina surrounding the fovea, which itself appeared as a small red disk, could

be seen. Occasionally minute yellowish or white spots would appear in that area. Later on the macular area showed fine pigment changes. Only once did it seem as if the refraction of the cloudy portion of the retina was weaker than the surrounding by 1 to 2 D. Nine years after the first attack of the right eye similar symptoms appeared in the left one. The case is one of the mildest recorded and its characteristics are: the attacks increased in frequency; the positive scotoma, at first present only during attacks, becoming permanent later on; the diminution of central vision was never great; the discomfort was more occasioned by the scotoma which the patient felt as a dark spot on the paper when reading; the ophthalmoscopic changes were very slight. As to the anatomical basis for the affection, Fuchs assumes that the opacity of the retina lies in the retina itself, especially in the inner layers, and not behind it; because the foveal area is seen as a red disk on account of its great thinness, and because the rods and cones functioned fairly well as evidenced by the positive scotoma and the fair vision. The changes may have been produced by liquid exudate (edema) into the inner layers of the retina. Fuchs could not subscribe to the views of Leber of a circumscribed retinal detachment. The ultimate cause lies apparently in an affection of the arteries supplying this region. The relapsing character of the affection can thus be explained most easily.

Retinitis circinata. This subject has already been treated under **Circinate retinitis,** on p. 2253, Vol. III of this *Encyclopedia.* Here it may be further said that H. L. Begle (*Am. Journ. of Ophthalm.,* Sept., 1912) reports on three of these rare cases and says that "as regards the etiology of retinitis circinata, it is of interest to note that all three of these patients were past middle age. While definite signs of sclerosis of the retinal vessels were not observed, that circulatory disturbances were present is suggested by the presence of incipient cataracts in all the cases, a relatively high blood pressure and increased tension in the second patient, and such signs of general arteriosclerosis in the third patient as accentuation of the second sound of the heart, stiffness of the radial artery and hyaline casts in the urine. So far as known, in only one case previously reported was retinitis circinata associated with glaucoma and that was the one described by Ammann. No relation is suggested between an increase of tension and the retinitis circinata in the second patient other than would arise from a common origin in a diseased vascular system. The presence of yellowish areas in and about the macula, as described, instead of retinal hemorrhages, leads to the belief that the white patches in these cases arose from fatty or other degenerative changes occurring in retinal

exudates, the latter in turn arising from disease of the smaller macular vessels."

Bishop Harman has reported a case in which the white patches appeared in the right fundus, first as an arch above the macula, and a month later additional patches below and toward the disk. Vision



Retinitis Circinata. (deSchweinitz.)

was reduced to 6/60. One year later vision had risen to 6/12, and all trace of the fundus lesions had disappeared. Grimsdale gives the history of a patient whose right eye showed spots in the macular region resembling glyseosuric changes, although there was no glycosuria or other general disease. The vision was 6/36. The left eye was cataractous, but after removal of the lens it was found that the macular region of this eye was also diseased, and the appearance changed afterwards to that of retinitis circinata.

D. H. Coover (*Annals of Ophthalm.*, p. 182, Jan., 1913) reported the case of a woman, aged 62, who complained of indistinct vision in

the left eye, and of difficulty in seeing to sew or read. Vision was: Right, 5/60, not improved by lens; left, with correcting lens,= 6/10. The vessels of the right retina were contracted, the nerve-head white, and there were atrophic changes in the macula, but no exudate was present in the eye. In the left eye, glistening, whitish deposits surrounded the macula for a considerable area. In the macula itself the exudate was not quite so heavy. The exudate lay beneath the vessels, and there was a small hemorrhage on a vessel running down towards the macula. The general health was apparently good. Blood pressure, 135 mm. Hg. Wassermann test was negative, and there was no indication of kidney disease. There were cortical striæ in the lower nasal quadrant of each lens. The patient had been seen a year earlier by Libby, who reported that at that time he had observed a whitish, tessellated exudate lying along the inferior temporal artery and vein beyond the macular region, which showed recent inflammatory disturbance.

Harms (*Oph. Year-Book,* p. 230, 1913) deals with the macular changes in retinitis circinata, which he finds follow the white spots that go to make up the girdle in some cases; or, the disease may begin in the macula, and the girdle of white appears later, or not at all.

A case of degenerative change at the macula in the left eye, with apparently an arterio-venous anastomosis and large vessels entering the area is reported in a case described by Mosso. The diseased area was about the size of the optic disk. The patient, a man of 21, gave the history of progressive impairment of vision after typhus fever two years before.

Seven examples of circinate retinitis are reported (Graefe's *Archiv f. Ophthalm.,* 86, 3, 1913), by Heinricy and Harms. The ages of the patients ranged from 24 to 79 years, the two patients under 57 presenting atypical conditions. In three of the cases only one eye was affected, but the lesions were regarded as typical, although the wreath or girdle varied greatly from the oval or circular form. In one case the white patches outlined almost a square with its center in the macula, and one angle near the optic disk. In two cases the lesions were unilateral and typical, in that they consisted of irregular rings not inclosing the macula, but distributed in one case to the nasal side of the disk, and in the other in the macular region and beyond. The remaining two cases exhibited the typical form of white patches in the retina, a horizontal oval with the macula at its center.

The writers have reviewed the cases recorded in the literature to the number of forty unilateral and twenty-three bilateral. Of the latter fourteen have presented circinate lesions in both eyes; eight both

eyes atypical, and one with one eye showing the typical appearance and the other not typical. Apart from the characteristic white patches, the other parts of the eye were often normal in appearance, the disk usually unchanged, only rarely hyperemic or slightly pale. The periphery of the fundus also occasionally showed small hemorrhages or specks of white, or pigment, or cholesterin crystals, etc. The condition of the retinal vessels varied greatly; some appearing quite normal and others presenting marked changes, especially of sclerosis. In the unilateral cases the good eye often presented some of these general fundus changes, but mostly in slighter degree than the eye presenting the circinate patches. The disease is painless and the onset of the first symptom, visual disturbance, gradual. Central vision is always affected, but contraction of the peripheral visual field is very rare. The ophthalmoscopic appearance may remain stationary for years, but progressive and regressive changes have often been observed. It is possible for all visible lesions to disappear, leaving no sign of the earlier disease.

Special note of the general condition of the patients in 52 cases shows that there were 5 cases of heart disease, 24 of arteriosclerosis, 6 of diabetes, 1 gout with albuminuria, 3 syphilis; 1 a case of leukemia, and 3 of anemia. In 5, other accidental diseases were mentioned, and 4 patients were said to be free from general disease.

The investigators believe that inasmuch as of 52 cases 38 (75 per cent.) suffered from disease of blood vessels, and 4 cases (7.7 per cent.) from disease of the blood, vascular disease is an important etiological factor in retinitis circinata. No case has been examined histologically, and therefore it is impossible to say exactly how the vascular disease affects the deeper portions of the retina, but apparently the choroidal vessels surrounding the macular area are affected and thus produce the ring-like effect. The later hemorrhages are evidence of advancing disease of the vessels. The retinal vessels are not necessarily involved at all.

In an *atypical case of circinate retinitis* described by Ernst Bachstez (*Klin. Monatsbl. f. Augenheilk.*, Aug., 1913) there was the usual implication of the macular region but the white wreath extended upward entirely above the disc and macula and was about 6 disk diameters across. The patient, a woman, aged 62, had suffered from failing vision in the left eye for five years. She was affected with myocarditis and general arteriosclerosis. In the right fundus there were vascular changes in the shape of tortuosity and variations of calibre of the arteries. Vision was good. In the left eye there was a large central scotoma, and vision was reduced to counting fingers in ec-

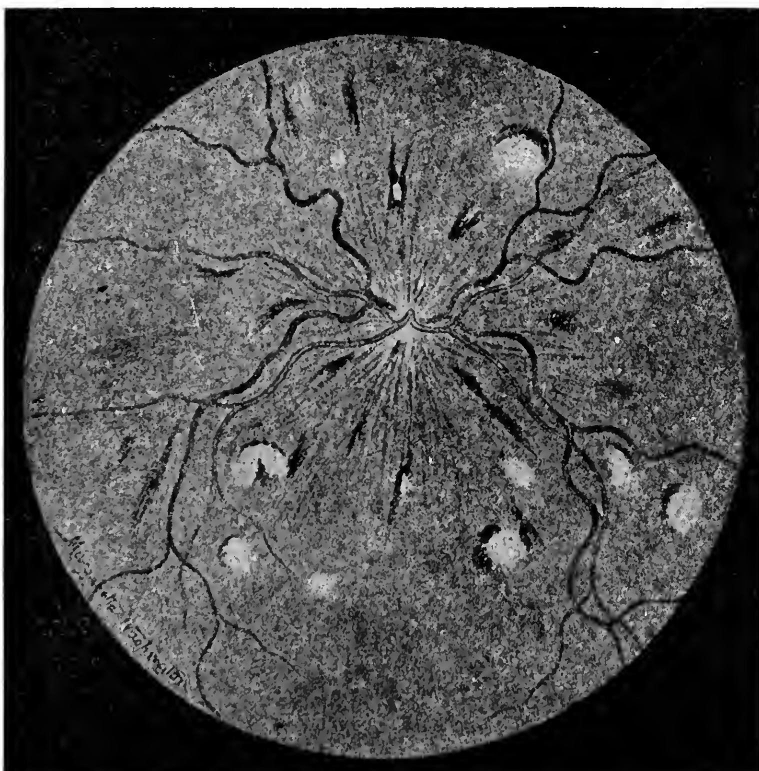
centric portions of the field. Ophthalmoscopic examination showed, in the macular region, a gray opaque area, 1.5 disc-breadths in diameter, and at its center a smaller yellowish patch. Above the disc and macula there was a large ring, whose lower margin touched the macular patch, and just avoided the margin of the disc. In this ring two kinds of change could be made out and satisfactorily differentiated by Gullstrand's binocular ophthalmoscope. The first consisted of discrete white spots, situated deeply in the retina, and the second of more solid looking opacity, situated at a more superficial level slightly elevated, crossed by slightly veiled and altered vessels, and with one or two hemorrhages in its neighborhood. The white, sharply-defined spots closely resembled those of retinitis circinata, but it was atypical in its situation and in its association with the more superficial retinal opacity. The macular change was also in some respects atypical.

The *Oph. Year-Book* (p. 211, 1916) abstracts the following two papers. Goldberg's patient showed a purplish red area in each macula with a yellow spot in center; encircling the macula was a zone of healthy retina surrounded by the ring of pale-pink and bright-white spots. Wassermann positive. Blake was able to see the fundus in his case before any pathologic changes appeared; later when hemorrhages showed up and finally when these were superceded by the typical white patches. He considers his case the ophthalmological proof of Ammann's interpretation that hemorrhages always precede the white patches of this disease.

Retinitis circumpapillaris. According to Magnus (*Encyklopädie der Augenheilk.*, p. 714) this is a form of simple retinitis which is especially found in the neighborhood of the optic disk. The papilla is beclouded by a veil-like obstruction that obscures its outlines. The retinal veins are large and prominent but the arteries are narrowed. Occasionally all the vessels are hidden by the cloudy deposit. Sometimes it is difficult to diagnose this condition as in brunettes the (normal) zone about the nerve head presents a quite similar appearance. The prognosis is often doubtful, as the etiology is equally obscure. Magnus advises sweat baths, mercurial inunctions, laxatives, confinement in a darkened chamber and free abstraction of blood from the temples.

Retinitis, Circumscribed. Weeks (*Text-Book*, p. 467) describes under this caption a form of syphilitic chorioretinitis that presents large, isolated white or yellowish-white patches, into which the diseased retinal vessel around which each patch seems to have formed may be seen to enter. A number of these foci are scattered over the

fundus, and although the patches may be quite small they are often two or even three disk diameters across and distinctly elevated. Hemorrhages are often seen, with exudates into the retina; and cloudy vitreous. The fundus may be free of other signs of inflammation but in many cases there are also papillary hyperemia and dilated retinal veins, not to mention large floating opacities in the



Ophthalmoscopic Appearances in Diabetic Retinitis. (Ball.)

vitreous. When the process subsides there remain large, circular or lobulated atrophic areas whose appearance is due to the formation of connective tissue. This disease may, in some of its stages, be mistaken for tubercle of the choroid or subretinal cysticercus. See **Retinitis, Syphilitic.**

Retinitis, Deep. A synonym for parenchymatous keratitis.

Retinitis, Diabetic. GLYCOSURIC RETINITIS. In addition to the matter found on p. 3924, Vol. V of this *Encyclopedia*, it may be said here

that retinal changes due to diabetes are of rare occurrence and of such doubtful individuality that some prominent ophthalmologists have questioned the propriety of assigning to it a separate place among affections of the retina. As regards the frequency of ocular affections associated with glycosuria, the reports of different observers vary greatly. Hirschberg believes that the ocular changes are often overlooked. Lagrange, among 20,000 eye cases, found 53 with diabetes; and, of 100 diabetic patients, W. O. Moore found 21 with ocular diseases, 5 having retinitis. Visual disturbances may occur in diabetes without ophthalmoscopic signs (amblyopia of diabetes). While it is usually bilateral, there are no pathognomonic signs. It is an uncommon disease, Schöbl, in a rich clinical experience, having met with only 9 such cases.

Diabetic retinal affections are divisible into five classes: (1) central punctate diabetic retinitis; (2) hemorrhagic diabetic retinitis; (3) diabetic albuminuric retinitis; (4) albuminuric retinitis in the eyes of diabetic subjects; (5) atypical diabetic retinitis. The retinal changes occur late in the disease and usually in diabetes mellitus, but have been seen also in diabetes insipidus. As a rule, diabetic retinitis shows more hemorrhages and a smaller number of white plaques than does albuminuric retinitis. Groenouw and Uhthoff state that vitreous opacities, which are not found in albuminuric retinitis, may play an important rôle and may lead to blindness in diabetic retinitis. The descriptions given by various authors of the ophthalmoscopic appearance of diabetic retinitis are very different, and all, to a certain extent, resemble the findings in albuminuric retinitis.

In the central punctate form of diabetic retinitis the optic nerve is not affected, while in the posterior pole the fundus shows numerous ivory-white spots, streaks, or points surrounding the macula in an irregular manner. The stellate figure found in albuminuric retinitis is wanting. The spots may be round, ovoid, irregular, or semilunar in shape, and may present serrated margins. They are more frequently found on the temporal than on the nasal side of the optic disc. The white spots may remain for years. They do not coalesce, and between them are seen small hemorrhagic spots. The vitreous is clear, there is no change in the pigment, and the periphery of the fundus is unaffected. In hemorrhagic diabetic retinitis there are numerous hemorrhages, but no white spots. These cases may end in hemorrhagic glaucoma. In the third group a composite picture exists, formed of the white spots of the diabetic affection and swollen nerve-head and retina, together with the vascular changes of albuminuric retinitis. The urine of such patients presents sugar and albumin. In the fourth

class the general symptoms of diabetes exist with the ophthalmoscopic picture of albuminuric retinitis. In the atypical form cases have been described which seem to be pigmentary retinitis with subsequent accidental development of diabetes. Contraction of the visual field and night-blindness are present. Schöbl saw a case—in a patient whose urine showed 3 per cent. of sugar and no albumin—in which large white plaques were numerous in the periphery of the fundus, while irregular clusters of small, white spots were found in the macular region. Some cases of diabetic retinitis show atrophy of the optic nerve, hemorrhages and opacities in the vitreous, amblyopia, scotomata, choroiditis, and hemorrhagic glaucoma.

In a case of diabetic retinitis Nettleship found a hyalin degeneration of the intima in the small arteries of the retina, the brain, kidneys, etc. All the layers of the retina, and particularly the nerve-fibre layer, were thickened by chronic edema and hypertrophy of the supportive connective tissue. The nerve-fibre layer showed varicosities. and the small retinal arteries presented miliary aneurisms. Von Michel has reported glycogenic degeneration of the retina in diabetes.

Frequently the diagnosis cannot be made with the ophthalmoscope alone. An examination of the urine will reveal the true nature of the case. Specific choroidoretinitis punctata albescens may cause confusion. Attention to the general symptoms of the patient and repeated examinations of the urine may be required to clear the diagnosis. The ophthalmoscopic differences between diabetic and albuminuric retinitis have been tabulated by Dodd, as follows:—

Diabetic retinitis.	Albuminuric retinitis.
1. Groups of bright, glancing spots in the retina, irregular in outline, usually in the central part, but frequently affecting the whole of the fundus.	1. At first a group of bright, bluish-white spots is present in the centre of the retina, often forming a stellate patch about the macula.
2. If the spots are large there still exist small dots and lines, and they never run together.	2. The spots may run together and involve all of the central part of the retina.
3. The arteries and veins are not much changed in appearance.	3. The arteries are narrowed; the veins are large and irregular.
4. The optic nerve is either not affected or is atrophic.	4. The optic nerve is swollen and its outline is indistinct.
5. The retina is not diffusely affected.	5. The retina is infiltrated.

As a rule, retinitis is a late and serious symptom in diabetes. While the retinal affection probably never causes complete blindness, except when glaucoma follows the hemorrhagic form, yet there is considerable loss of vision and the outlook for improvement is not favorable. While it is nearly always binocular, one eye may progress much more rapidly than the other. In the hemorrhagic glaucoma of diabetes the

prognosis is most unfavorable. The treatment is that of the general disease.—(J. M. B.)

Hawthorne emphasizes the fact that retinal changes—hemorrhages and retinitis—may be present in glycosuric patients who, but for these changes and for the fact of the glycosuria, are wholly free from evidences of organic disease. Glycosuria may disappear while the retinal conditions persist, and in some stages of the clinical history of these cases the ophthalmoscopic facts may be difficult of interpretation.

Retinitis, Diffuse (syphilitic). See **Retinitis, Syphilitic.**

Retinitis, Electric. See **Retinitis from excessive light.**

Retinitis, Embolic. See **Retinitis, Metastatic.**

Retinitis exudativa. MASSIVE EXUDATION OF THE RETINA (COATS). HIPPEL'S RETINITIS. See, also **Retinal disease with massive exudate**; as well as **Retina, Juvenile diseases of the.**

Geo. Coats described (1909) this condition as a disease of the retina, (hitherto insufficiently differentiated) characterized by the presence in the fundus of large masses of white or yellow exudation; usually there are also groups of cholesterin crystals and hemorrhage. Later, the same writer (*Ophthalmic Review*, July, 1911), in a report of ten cases of this unusual disease of the retina modified a former classification into (1) those cases without gross vascular disease; (2) those with gross vascular disease. The third class he formerly recognized as cases with arteriovenous communication are now excluded, being regarded as a quite different disease, angiomatosis. He recognizes, however, that this group may still include cases differing in etiology and pathology. Two of his cases presented multiple miliary aneurysms (as described by Leber). He thinks hemorrhage is always an important factor, but in different cases the hemorrhages may be due to different causes. Coats suggests for such cases the name retinitis hemorrhagica externa, and admits a relationship to retinitis circinata. In discussing the causes of hemorrhage he finds no clear evidence of an abnormal condition of the blood in the cases subjected to blood examination, and favors the hypothesis of local vascular disease, although in some cases this has not been demonstrated ophthalmoscopically, or by the microscope. One of his cases has been under observation by different ophthalmologists for sixteen years, vision remaining about the same, 6/60 until the last attack, when it fell to 3/60. In this case the cause of the hemorrhages remained obscure. In this connection, see **Retina, Aneurysm of the**; as well as **Retina, Angiomatosis of the**, p. 11191, Vol. XIV of this *Encyclopedia*.

Greeves (*Oph. Year-Book*, p. 245, 1912), reports the examination

of an eye from a boy aged 6, in which the retina was detached and pushed forward by a highly organized mass of fibrous tissue surrounding the papilla and also represented in the outer layers of the retina. There were recent hemorrhages and spaces containing cholesterin crystals. This condition was evidently chronic, and the history of instrumental delivery suggested possible birth injury. There was no vascular disease, and blood-coagulation was normal. McMullen saw a mass in the retina four times the diameter of the disk, with distended tortuous vessels entering it, and a few hemorrhages in the mass and the adjoining retina. The patient was a man of 20, who had suffered from extreme fever a few months previously.

Cords reports a case of exudative retinitis affecting one eye, the other being normal. In this case there was a periphlebitis. Poor vision had been noticed for three weeks. The retina was gray, thickened, and showed lighter spots. In the two cases of Teulières, vision had first been impaired years before. There were hemorrhages and numerous white or gray bands in the fundus of the eye giving the picture of proliferating retinitis. Diem records a case in which failure of vision had first occurred six years before, and partial recovery followed injections of mercury. The fundus showed prominent whitish spots over which the retinal vessels passed. The principal of these were arranged in a broad band encircling the macula, the appearances being strikingly similar in the two eyes.

Collins saw a boy of 13 with one eye found defective at the school inspection. It presented an intensely white area in the macular region, with other white spots and irregular patches in the choroid and beneath the retinal vessels. Cruise saw a young man with a mass of fibrosed retinal detachment, apparently of long standing, around the disk and involving the macula. The skin reaction to tuberculin was positive, the Wassermann reaction negative.

Paton reports the case of a boy of 9½ years, whose vision was found defective in the left eye. When seen six weeks later there was a yellowish-white patch in the macula, with a depressed whiter center, in which floated a film continuous with the retina. From the patch radiating lines of similar exudate continued with white dots, formed one-third of a star-shaped figure, and softer yellowish dots were seen toward the disk and in other parts of the fundus. Intervening parts of the retina were edematous and there was a shallow detachment in the macular region. The right eye was normal. The boy was free from organic disease and his urine normal.

Hajano (Graefe's *Archiv f. Ophtalm.*, Vol. 84, 1, p. 30; review by Geo. Coats, *Oph. Review*, p. 145, May, 1913) reports a case of exuda-

tive retinitis in a child aged two years. A white reflex from the vitreous had been noticed for six months. The anterior chamber was shallow, the pupil slightly dilated, the tension raised. Behind the lens three yellowish-white prominences were visible, with hemorrhages on their surface and tortuous vessels coursing over them. Glioma was diagnosed, and the eye was enucleated.

Pathologically there was a total detachment of the retina with some hemorrhage in the subretinal space. The retina was thickened and folded, especially on its outer aspect. The nuclear layers were degenerate and spaces were present containing swollen cells with peripherally placed nuclei. In the anterior part of the retina large cavities were found, and in this region also there were many large hemorrhages chiefly in the nerve fibre layer. The vessels of the second and third magnitude were thick-walled, and small, thickened vessels were especially numerous in the inner nuclear layer. The choroid and ciliary body were flattened but free from infiltration; the iris thin; the corneo-iridic angle occluded; some slight posterior synechiæ were present, affording evidence of a mild degree of inflammation.

Hajano believes that the primary lesion was an arterio-sclerosis in the smaller branches of the retinal vessels, but he offers no opinion as to the cause of such a condition in a child of two. This arterio-sclerosis probably caused the retinal hemorrhage and degeneration, and no doubt the detachment was also secondary. The masses of fibrous tissue between the retina and choroid which are so characteristic of this disease seem to have been absent, and possibly this may throw some doubt on the diagnosis. The early age of the patient is of interest and suggests a natal or pre-natal origin of the disease.

Three clinical cases of probably the same condition are also briefly reported. The ages of the patients were 24, 18, and 16 respectively. All were healthy and showed no evidence of albuminuria, glycosuria, syphilis, or tuberculosis. In all three also the condition was unilateral.

An important paper on this subject is that of E. von Hippel (*Archiv f. Ophthalm.*, Vol. 86, 3, p. 443, 1913; abstracted and reviewed in the *Oph. Review*, p. 50, Feb., 1914). The case upon which the essay was founded occurred in a woman aged 49. When first seen she had complained of spots before the left eye for fourteen days; vision, 4/4. There was vitreous opacity, and in the extreme periphery downwards and outwards, two elongated dark circumscribed areas were visible in the fundus. The vitreous opacity rapidly increased, and in ten days the vision had fallen to below 4/15. The patient continued under observation for nearly two and a quarter years, during which the areas gradually increased in size, and new patches formed in

their vicinity. About one and a quarter years after the onset an area was also discovered in the extreme upper periphery. Enucleation was finally necessitated by an attack of iridocyclitis. The patient's health was good. Wassermann and tuberculin reactions negative. Slight enlargement of the thyroid. Blood examination—Hb. 65 per cent. Corpuscles 3,580,000. No albuminuria or glycosuria.

Microscopical examination showed only slight changes anteriorly—pigment in the spaces of Fontana, commencing adhesion of the root of the iris, synechiæ, some infiltrates in the iris stroma. The retina was thickened and detached, and from its outer aspect nodules projected into the subretinal space. Between the retina and choroid there was a layer of organizing tissue, thin on the surface of tho choroid, thick on the outer aspect of the retina. A similar layer was present on the inner aspect of the retina. Both were much more developed and more intimately adherent to the retina anteriorly than posteriorly: it was somewhat doubtful whether the membranes were vascularized from the retina or from the uvea in the neighborhood of the ora serrata. The retina itself had undergone much degeneration, and in places was invaded and destroyed by cicatricial bands; the retinal vessels did not show gross disease, but were often ensheathed with leucocytes. The subretinal nodules consisted of a homogeneous or fibrous tissue, containing crystal-clefts, scattered pigment granules, and pigmented ghost cells. Posteriorly the choroid was little altered, anteriorly it was considerably infiltrated, and in places its inner layers were much disorganized. The hemosiderin reaction showed the presence of blood pigment in the retina (scantily), on the surface of the retinal membranes, in places in the subretinal space, and in the fibrous membranes between the retina and choroid. The epithelial elements, however, showed none of the staining which is commonly found in hematogenous siderosis, and from this circumstance, and the scarcity of cholesterin, the author concludes that there had been no considerable extravasations of blood.

v. Hippel believes that the disease began in the anterior part of the eye, and that the exudation spread backwards on both aspects of the retina from that region. The presence of recent round cell infiltration showed that the process was distinctly inflammatory and not due merely to the organization of retinal hemorrhage. The choroid undoubtedly had a large share in the process, but the author considers that the formation of membranes and the infiltration along the retinal vessels point to the co-existence of an independent retinitis. The question whether the disease was primarily a retinitis with secondary involvement of the choroid, or vice versa, is discussed.

The points in which this case diverges from the ordinary type of exudative retinitis are the somewhat advanced age of the patient, the commencement in the periphery and the very clear evidence of inflammation in the choroid. The first two points are probably not of great significance, but the last is important. Considering the very chronic course of exudative retinitis, v. Hippel regards his case as a comparatively early one. He supposes that if the inflammatory infiltration had subsequently disappeared, a condition of affairs would be produced closely resembling that which was found by the reviewer in some of his older cases. The reviewer's earliest case, however, whether judged by the clinical history or by the degree of organization in the pathological exudates, was of much shorter duration than v. Hippel's; yet the choroid was almost entirely free from change. It may be admitted that round-cell infiltration might disappear leaving no trace; but it is impossible to believe that a large organized subretinal exudate could be derived from the choroid without disorganization of the inner layers of that tunic, and without the formation of firm adhesions. From this early case of the reviewer's series of gradations led to the older, more advanced changes; but in all there was the same disproportionately slight involvement of the choroid as compared with the intimate relation of the exudate with the retina. In some of his cases at least it is certain that the primary process was purely retinal, and since the evidence of considerable choroidal inflammation in v. Hippel's description is unequivocal, it becomes questionable whether his case should be reckoned as a true instance of exudative retinitis, or whether, as v. Hippel suggests in one place, it may not have been a choroiditis or choroido-retinitis due to a metastasis of some organism of a low degree of virulence. Undoubtedly, however, there are points of resemblance to exudative retinitis, and the reporting of this, and similar cases is to be welcomed as forming a basis for the future more exact classification of that disease and of other obscure, and perhaps allied conditions.

Komoto (Graefe's *Archiv f. Ophthalm.*, 84, 1, p. 30), gives the history of a boy, aged 2, in whose right pupil was noticed at lamp light a white "shine" which had become more and more distinct. The cornea was slightly opaque, anterior chamber shallow, pupil slightly dilated. Behind the lens appeared 3 yellowish-white prominences with tortuous vessels and diffuse hemorrhages; fundus not visible. The eye was in the glaucomatous state. The diagnosis of glioma was made, the eye immediately enucleated, and sections variously stained. A meridional section at once showed that the diagnosis of glioma was erroneous. The chief changes were in the completely detached retina,

which was thickened and folded. The layers of the rods and cones, the outer and inner granules and ganglia were extensively degenerated. The retinal elements were partly replaced by an irregular lacunar system with cystoid formations and hemorrhages. The vessels were very much thickened and knotty, some completely obliterated by proliferations in the adventitia and endothelium. Choroid, ciliary body, and iris were thickened, anterior and posterior chambers filled with an amorphous mass.

The histologic changes showed that the affection was not inflammatory but a degenerative process, which most likely started from the arterio-sclerosis of the vessels, especially of the branches of second and third sizes, with multiple hemorrhages and degenerations of the retina and simultaneous and successive edematous infiltrations. The etiology was not known; perhaps the disease was of congenital origin.

Coats (*Oph. Review*, p. 10, Jan., 1915), also reviews at length the essay of H. Friedenwald (*Trans. Am. Ophthal. Soc.*, XIII, p. 819, 1914). The paper covers five cases of retinitis with massive exudation. (1) In a man, aged 18, vision had failed gradually after an attack of typhoid fever two years previously. The inner, upper, and lower regions of the left retina up to the extreme periphery were occupied by an exudation, in part uniformly white, in part mottled. In the periphery there were numerous fine hemorrhages. At one place in the upper part of the fundus a white mass rose to a height of 12 D.; a similar mass was also present below. Near the disc, especially on the nasal side, there were numerous whitish spots, many of them confluent, while below, and partially surrounding the disc, there was a uniform white surface. Nasally many small hemorrhages were present. The blood vessels were much diseased. The vitreous showed fine dust-like opacity. Vision 6/36. Right eye normal. Earlier stages of the same changes had been observed by Randolph eighteen months previously. Except for a probably functional albuminuria the patient's health was quite good. No syphilis.

Subsequently new hemorrhages were observed on one or two occasions, and the fundus changes gradually progressed. About sixteen months after his first visit raised tension supervened, with a new formation of vessels on the iris, and the eye was enucleated after a total period of observation by the author of two years.

Pathological examination by Verhoeff showed, between the retina and choroid, masses of hyalin fibrous tissue, many of which contained deposits of cholesterin crystals. The retina was extremely degenerate, and its vessels were much diseased. The central artery, cut in transverse serial sections, showed partial occlusion from endarteritis, and

endophlebitis was also present. The choroid was normal except where the retina adhered. The iris was atrophic and the corneo-iridic angle occluded. Verhoeff considered the case to be one of obstruction of the central artery and vein from proliferative endovasculitis.

(2) In a woman, aged 22, an extensive white area with a prominent mass was found in the lower inner portion of the left retina. In the lower nasal quadrant also there was an area of exudation. None of it came within 5 or 6 PD, of the disc. The papilla was congested, the veins sinuous, and enlarged tortuous vessels ran over the white surface. The right eye had been operated upon for cataract, and was blind from the results of iridocyclitis. It was subsequently enucleated. The patient was in good health, but had suffered from syphilis; the tuberculin reaction was positive, but no improvement followed the therapeutic use of this agent; blood pressure 125, heart sounds normal; nothing abnormal in the blood count; no albumin or sugar in the urine.

In the further course of the case there were periods of quiescence followed by periods of activity, the total result being a gradual progress, with fresh hemorrhages and spots of exudation. Finally detachment of the retina took place, and vision was reduced to the perception of hand movements. Microscopical examination of the other eye showed an organizing inflammatory mass connected with the retina, and also an area of chronic choroiditis with bone formation. It was impossible to affirm positively whether the retinal affection was the same in the two eyes.

(3) A girl, aged 11, suffered from high arterial tension, albuminuria and dropsy. In the right eye there was an extensive detachment, with retinal hemorrhage; in the left there was intense neuro-retinitis. Nasally and in other parts of the periphery massive white exudates were observed. The patient died four weeks later.

(4) In the right eye of a boy, aged 4, the entire central region of the retina was converted into an intensely white surface, involving both the disc and macula. At its edge it broke up into smaller spots. Vitreous opacity was present. Enlargement of the veins was the only vascular change. The v. Pirquet test was negative, and in other respects the child was quite healthy. Subsequently masses of minute vessels developed in the extreme temporal and lower periphery, the exudation became more extensive, and crystals and hemorrhages were observed on its surface. The diseased area was not appreciably elevated.

(5) A man, aged 17, accidentally discovered that the sight of the right eye was defective. The blood pressure was somewhat high, there

were some hyalin casts but no albumin in the urine. He had suffered from malaria; interstitial nephritis was suspected. Left eye normal. In the right the vessels on the disc were considerably enlarged. The whole of the macular region showed extensive exudation. In parts the retina was detached to the extent of 8 D. Numerous red spots due to convoluted and enormously enlarged veins were present, and in places there were large numbers of capillary vessels. Beyond this area the veins showed great variation in calibre with varix-like enlargements, and some of the vessels outside the affected region were diseased.

Friedenwald's first case shows all the clinical and pathological features which characterize the group. In the second there was more evidence of active inflammation than has been commonly recorded, and since the fundus of the eye microscopically examined had not been seen with the ophthalmoscope, and since also the eye had been lost from an inflammatory lesion, the exact interpretation of the pathological findings must be a little in doubt. The fifth case, as the author points out, is a classical example of the group characterized by the development of miliary aneurisms, and recently separated off by Leber as a separate type.

J. W. Jervey (*Am. Journ. of Ophthalm.*, p. 127, Feb., 1919), has given a history of four cases of *nonhemorrhagic, hyperplastic exudative retinitis* and after a study of them concludes that the disease is a retinal pathologic entity consisting of organized hyperplastic tissue evolved from fibrinous or plastic retinal exudates of indeterminate origin.

These exudates are not of hemorrhagic character, though it would appear that they must necessarily have a vascular pathogenesis; and the tissue into which they are determined would seem to be analogous to granulation or chronic inflammatory tissue.

Jervey further says that the clinical phenomena manifested can evidently be divorced from syphilitic, tubercular, or traumatic causation, though unquestionably resembling the lesions sometimes seen consequent upon these origins.

The hyperplastic organizations are characterized by a white, grayish, yellowish or mottled appearance in form suggesting a piece of popcorn or miniature cumulus clouds, showing a fine vascularity at some period of their development; of no fixed size; usually, it would seem, in one mass, often highly elevated from the retinal level; when in the active formative stage usually with well-marked peripheral definitions; with a minimum of pigmentation or none at all; and, in the writer's observation at least, with points of selection for their

development either in the papillary or macular area. If in the disc area the organized exudates probably always extend along the nerve trunk beneath the sheath. They are, of course, essentially benign.

As the pathologic morphology and clinical appearances of these lesions are evidently similar (though usually distinguishable by location, arrangement, anamnesis, and instruments and methods of precision), to those of retinitis circinata, retinitis proliferans of nonhemorrhagic origin, and certain forms of syphilitic, traumatic and perhaps tuberculous retinitis, it would seem appropriate for clinical study and for the minimizing of a certain obscurity, to group all of these, for differentiation from other types, under the descriptive heads of nonhemorrhagic hyperplastic exudative retinitis.

Retinitis from concussion. CONCUSSION OF THE RETINA. See **Retinitis, Traumatic**; as well as **Retina, Injuries of the.**

Retinitis from excessive light. SOLAR RETINITIS. ELECTRIC RETINITIS. ECLIPSE BLINDNESS. SNOW BLINDNESS. Conjunctivitis, keratitis, and retinitis may be produced by exposure to excessive light, either from looking at the sun (solar retinitis), from reflection from the snow (snow-blindness), from the injurious effect of electric light (electric ophthalmia), or from a flash of lightning. Radium emanations may cause retinitis and atrophy of the globe; and x-ray exposures may produce changes in the optic nerve and retina.

Solar retinitis. Blinding of the retina from looking at the sun has occurred in a number of cases, chiefly from the observation of solar eclipses. The patient will show a central scotoma (which may be absolute), defective color-vision, metamorphopsia, and reduced acuity of vision. The duration and extent of these symptoms will depend upon the length of exposure and the intensity of the sunlight. Ophthalmoscopic changes may be absent, or may include loss of the macular reflex, the presence of a small spot of an orange-color near the fovea, with alterations in pigmentation. The prognosis in solar retinitis must be guarded. Severe cases do not improve. Swanzy states that hitherto no case in which vision was reduced to less than one-third has recovered full visual acuity. The treatment will include rest, the wearing of dark glasses, the hypodermic injection of strychnia, and the use of the constant galvanic current. See **Eclipse amblyopia,** p. 4127, Vol. VI of this *Encyclopedia.*

Snow-blindness. Exposure of the eyes to the reflection from snow causes ocular changes, and may lead to permanent blindness. Usually, however, the lesions are limited to the conjunctiva and cornea. There is intense photophobia, blepharospasm, and sometimes chemosis, together with the ordinary evidences of conjunctivitis.

The cornea may present dendriform ulceration. Some cases complain of the sensation of a foreign body in the conjunctiva. Noyes states that the retina may be anesthetic or hyperesthetic. The prognosis is favorable. The treatment includes rest, the wearing of smoked glasses, the use of holocain drops, and cold applications. See, also, **Blindness, Snow,** p. 1197, Vol. II of this *Encyclopedia;* also, **Glaring,** p. 5390, Vol. VII.

Electric ophthalmia. Exposure to flashes of electric light, during electric welding or from the short-circuiting of the current, may produce conjunctival, corneal, and retinal changes. The same changes may be found in electricians who use a strong arc light. In a few minutes, or perhaps several hours after exposure, the patient will complain of burning pain in the eyes, photophobia, blepharospasm, swelling of the lids, and perhaps reduction in vision. The pupil is strongly contracted. These symptoms are followed by a muco-purulent conjunctival discharge. Examination may show contraction of the field of vision, the presence of a small scotoma, congestion of the retinal veins, and slight haziness of the retina. Rivers saw a case in which there was exfoliation of the corneal epithelium and retinal opacity with great reduction in visual acuity. The patient's face and eyebrows were burned. See p. 4226, Vol. VI of this *Encyclopedia.*

While the prognosis is usually favorable in these cases, in the severer types of injury there may be permanent reduction in visual acuity, and pain and photophobia may be of long duration. Usually rest, the wearing of dark glasses, and the use of atropin will be followed by an early recovery. Pain in the acute stage may be relieved by the instillation of holocain and the application of cold compresses. —(J. M. B.)

Retinitis, Glycosuric. See **Retinitis, Diabetic.**

Retinitis, Gouty. Elderly subjects with the gouty diathesis often present lesions of the retina and retinal vessels. There is usually progressive impairment of vision of both eyes. Bull states that while the loss of central vision is marked, peripheral vision is little impaired, and gouty retinitis never ends in blindness. Ophthalmoscopic examination shows patches of yellowish-white exudation in the macular region and adjacent to the optic disc; hemorrhages, which occur for the most part in the early stages of the disease; opacity and thickening of the vessel-walls; and irregularity in the calibre of the arteries and veins. These patients show general arterial sclerosis. The urine is of high specific gravity. It contains an excess of uric acid and some albumin, but no casts are found in uncomplicated cases. The ophthalmoscopic picture is not sufficiently characteristic for diagnosis,

which, however, can be readily determined by exclusion. The pathologic changes in this disease include extensive arterio-sclerosis and phlebo-sclerosis, with obliteration of the smaller arterial branches; degeneration of the retinal layers and particularly thickening of the nerve-fibre layer of the retina from the presence of granular bodies; varicosities of nerve-fibres and changes in the choroidal vessels similar to those found in the retina. The prognosis is usually favorable as regards the retention of the amount of vision existing at the time of examination, but much depends upon the willingness of the patient to adopt dietetic and medicinal treatment. Many of these patients die from cerebral hemorrhage.—(J. M. B.)

Hutchinson (Weeks' *Diseases of the Eye,* p. 471), believes that many cases of hemorrhagic retinitis in young people are due to inherited gout and thinks they may be caused by thrombosis and partial blocking of the central vein of the retina. In these cases acute gouty retinitis does not set in, but slowly developing, chronic, retinal changes occur, showing as small, flame-shaped hemorrhages with many irregularly round, pale patches of exudation at the posterior pole. When these alterations appear in elderly people suffering from gout there is generally some impairment of vision.

Retinitis gravidarum. Gravidic retinitis. This is the so called *retinitis of pregnant women,* resembling the ordinary type of albuminuric retinitis. It usually appears in the later months of pregnancy, and is of grave import. See, in particular, under **Retinitis, Albuminuric;** also, under **Pregnancy,** p. 10335, Vol. XIII; as well as **Retinitis, Renal** and **Eclampsia,** p. 4127, Vol. VI of this *Encyclopedia.*

A few additional histories and observations of cases may be found in the *Ophthalmic Year-Book,* p. 209, 1916. Moore's patient of 26 years lost her sight two weeks before the birth of her child. One month later she showed symptoms of chronic nephritis with blood pressure at 240, and albuminuric retinitis with large bilateral lobulated detachment of the retina. Nine months afterward the detachment was gone, but there were atrophic changes in each retina. Westfall's patient of 35 years had eclampsia eight years before, and at the end of a subsequent pregnancy some blurring of sight with improvement after delivery; and three weeks after white spots in each macula, star-like and small hemorrhages here and there. The condition was considered as one of long standing. Amsler declares the prognosis of hemorrhages in the retina better in women than in men because some of the cases are caused by disturbances of the organs of generation, pregnancy, menopause, etc. Fagin presented a woman of 31, who had become almost blind at each of her two pregnancies, the last having

ended two months before. The ophthalmoscope showed disks blurred, veins large, arteries small, and old hemorrhagic spots. She was again recovering.

Retinitis, Guttate. See **Retinitis, Punctate.**

Retinitis, Hemorrhagic. APOPLECTIC RETINITIS. APOPLEXY OF THE RETINA. See, *inter alia,* on this subject, **Retinitis, Albuminuric,** and **Leukemia,** p. 7439, Vol. X of this *Encyclopedia.* A fair account of bleeding into the retina is also given on p. 5800, Vol. VIII.

Moore says that the high blood pressure in the large arteries (brachial) is the result of obstruction to the flow in the small vessels. We may, therefore, assume that the pressure is low in the retinal vessels while high in the brachial. For that reason slight pressure on the eyeball will produce pulsation of the retinal artery in arterio-sclerosis, so that intraocular pressure is not so high. Treatment to lower blood pressure is therefore contraindicated.

Marc Amsler (*La Clinique Ophthalm.,* May, 1916; review by Ernest Thomson in the *Br. Jour. of Oph.,* p. 187, March, 1917), publishes an exhaustive essay on hemorrhagic retinitis and analyzes 164 cases. He says that this condition is found in 4 per 1,000 cases, and presents various ophthalmoscopic appearances. It occurs especially between the years 50 and 70, and more often in women than in men. It is usually unilateral and seriously affects vision. It is almost always a manifestation of general disease. In more than one-half of the cases arterio-sclerosis is the cause. Among the etiological factors of the remainder are to be found cardiac diseases, albuminuria and glycosuria, arthritism and obesity, the menopause, and, more rarely, influenza. Not infrequently, the hemorrhage may be caused by some effort. The prognosis of hemorrhagic retinitis is good in 40 per cent. of cases. The favorable factors in these are, the female sex (especially at the menopause between 45 and 60 years); when the hemorrhages are pre-retinal, that is, hemorrhagic retinitis in the strict sense, the hemorrhages being few and peripapillary; a good condition of health, especially as regards the digestive system; appropriate treatment. The prognosis is bad in 60 per cent. of cases. The following are among the unfavorable conditions, namely, the male sex, advanced age, early arterio-sclerosis, fatigue, overwork, and general weakness. The appearance of hemorrhagic retinitis in an arterio-sclerotic subject makes one anticipate cerebral apoplexy. Thrombosis of the central vein is less rare than has been stated (1 in 2,000).

Retinitis hemorrhagica externa. A name suggested by George Coats for a form of retinitis exudativa (q. v.).

Retinitis, Hereditary central (Cargill). LEBER'S DISEASE. See p. 5841, Vol. VIII, and p. 5154, Vol. VII of this *Encyclopedia.*

Retinitis, Hippel's. A form of *retinitis exudativa* in which there are localized formations of new, aneurysmal vessels—an *angiomatosis retinæ.*

Retinitis, Hyperplastic exudative. See **Retinitis exudativa,** at the end of the section.

Retinitis, Hyperplastic hemorrhagic. This is a synonym of retinitis proliferans.

Retinitis, Jacobson's. Syphilitic retinitis.

Retinitis, Jensen's. A synonym of *retinochoroiditis juxtapapillaris.*

Retinitis juxtapapillaris. See **Retinochoroiditis juxtapapillaris.**

Retinitis, Leucocythemic. See **Retinitis, Leukemic.**

Retinitis, Leukemic. LEUCOCYTHEMIC RETINITIS. A form of the disease met with in leukemia, characterized by a diffuse, pale infiltration in the retina, and numerous small hemorrhages and white patches, which are partly due to varicose hypertrophy of the nerve-fibres and partly to fatty infiltration or infiltration with lymphoid corpuscles. These are met with both in the region of the macula and at the periphery, and are sometimes surrounded by a hemorrhagic margin. Vision is seriously affected. See **Leukemia,** p. 7439, Vol. X of this *Encyclopedia.*

Retinal changes, which occur in about 30 per cent. of cases of leucocythemia, have been divided into (1) leukemic papilloretinitis and (2) retinal hemorrhages or hemorrhagic retinitis in leukemic eyes. The disease occurs most frequently in splenic leucocythemia and as a late symptom. The characteristic features of splenic retinitis are the orange-yellow color of the fundus, the tortuosity and increased diameter of the veins, the presence of white spots with red borders in the fundus, and the presence of hemorrhages of various kinds and shapes. Often there is papillitis, which may be slight or marked. The affection is always bilateral and is incurable. The diagnosis, if in doubt, can be confirmed by a microscopic examination of the blood.

Among the complications of leucocythemic retinitis may be mentioned choroidal and vitreous hemorrhages, inflammation of a part or all of the uveal tract, hemorrhagic glaucoma, and exophthalmos from lymphomatous growths in the orbit.

Treatment of these cases must be directed to the improvement of the general condition of the patient, and is practically without value. —(J. M. B.)

Retinitis, Lipemic. See **Lipemia retinalis,** p. 7489, Vol. X of this *Encyclopedia.*

Retinitis, Luetic. See **Retinitis, Syphilitic.**

Retinitis, Macular. Pathological changes at the yellow spot more or

less inflammatory in character are not uncommon. Weeks classifies them as (1) edema, (2) minute points or spots of exudation, (3) hemorrhages, (4) pigmentary changes. All of these are described in detail under appropriate captions in this *Encyclopedia* and are as a rule intimately connected with changes in the underlying choroid. See, also, **Retinitis, Central.**

Retinitis, Metastatic. Retinitis from embolism. Purulent retinitis. Septic retinitis. Embolic retinitis. This process is described at length on p. 7664, Vol. X of this *Encyclopedia.* It may arise in the course of any one of many infectious diseases. The symptoms may be acute, resembling those of panophthalmitis, or chronic, resembling pseudo-neuroepithelioma of the retina. The anatomic changes in these affections may begin as a purulent retinitis, a purulent choroiditis, or as a choroidoretinitis. A form of metastatic retinitis which was first described by Roth as septic retinitis will here be considered.

Septic retinitis. To external examination an eye with septic retinitis shows nothing abnormal except possibly conjunctival hemorrhages. The dioptric media are clear. Characteristic changes found in the retina, in the neighborhood of the papilla and macula, are hemorrhages and white spots (Roth's spots), which vary much in shape and number. There may be a single spot or the foci may be numerous. The white spots may exist entirely apart from the hemorrhages or may lie within or adjacent to the latter. They never assume the stellate figure so often found in the macular region in cases of albuminuric retinitis; and, as a rule, they do not tend to become larger. They are absent in one-third of the cases, and rarely appear alone without hemorrhages. The hemorrhages are found chiefly along the large vessels, and seem to be of venous origin. Large preretinal effusions of blood are frequently found. Marked signs of inflammation are absent, the papilla being generally well defined. The retinal vessels are usually not changed in calibre, although the veins may be tortuous. In exceptional cases only one eye is involved. One eye may present the picture of septic retinitis while the other shows the changes of purulent choroiditis. As a rule, there is no great reduction in visual acuity. In some cases, however, the general weakness of the patient is so great as to prohibit an accurate examination of vision. Often the advent of the retinal changes cannot be determined with certainty. Ginurto has observed the disease as early as the fifth and as late as the twenty-third day after confinement. Septic retinitis has been observed in from 33 to 87 per cent. of cases of sepsis. It is found in all forms of sepsis, but is particularly frequent in septicemia. The disease runs a slow course, and, if the patient's life is spared,

complete recovery of the eye may occur. Although at the beginning the signs of metastatic choroiditis are similar to those of septic retinitis, a differentiation can soon be made. Metastatic choroiditis runs a rapid and destructive course with marked inflammatory symptoms. On the contrary, septic retinitis presents no inflammatory symptoms.

The *diagnosis* of septic retinitis must rest not alone on the ophthalmoscopic changes, but largely on the general history of the patient. Similar retinal changes, particularly hemorrhages, are found in many general diseases.

Treatment must be directed to the removal of the cause. Tonic and supportive measures will be required.—(J. M. B.) See, also, **Panophthalmitis**, p. 9230, Vol. XII of this *Encyclopedia*.

Retinitis, Naphthalinic. Mostly an experimental condition produced (like cataract) in rabbits when naphthalin has been given in large doses. Retinitis (as well as cataract) in man has been observed after the use of naphthol ointment prescribed in skin diseases. See **Naphthalin**, as well as **Naphthol**, p. 8287, Vol. XI of this *Encyclopedia*.

Retinitis nyctalopica. RETINITIS NYCTALOPIA (ARLT). A diffuse, streaked opacity of the retina and swelling of the disc, with central absolute or color scotoma and more or less marked amblyopia; formerly ascribed to retinitis, now regarded more as evidence of retrobulbar neuritis. See **Nyctalopia**, p. 8394, Vol. XI and p. 5764, Vol. VIII, of this *Encyclopedia*.

Retinitis of Bright's disease. See **Retinitis, Renal.**

Retinitis of pernicious anemia. See **Retinitis, Leukemic.**

Retinitis of pregnancy. See **Retinitis gravidarum.**

Retinitis oxalurica. A form of retinitis said to depend upon oxaluria, in which there are great disturbance of vision, marked cloudiness of the vitreous, occasional retinal hemorrhages, and small deposits of fatty degeneration, and more rarely proliferation of connective tissue in the retina. See **Retinitis, Renal.**

Retinitis paralytica. According to Magnus (*Encyklopädie der Augenheilk.*, p. 715), this is a retinal change seen in paralytics, characterized by a high degree of retinal clouding and a peculiar enlargement of the vessels. It is sometimes accompanied by hyperemia of the papilla. Some observers claim that a discloration of the choroid is visible beneath the retinal alterations.

Retinitis, Parenchymatous. DEEP RETINITIS. A chronic retinitis affecting most of the retinal tissues or layers.

While in serous retinitis the changes are limited to hyperemia and edema, in the parenchymatous form hyperplasia is added to these al-

terations, and the deeper layers of the retina are involved. Occasionally both serous and parenchymatous forms exist in the same eye at the same time. The cause of parenchymatous retinitis may be easily determined when the disease depends on renal or blood alterations or on cerebral lesions. In some cases no cause can be found. The pathologic changes include hyperemia, edema, round-cell infiltration, fatty degeneration, hemorrhages, and hyperplasia of connective tissue, with atrophy of the ganglion-cells. The walls of the capillaries undergo degeneraion. The process may end in one of three conditions: (1) absorption, leaving the retina practically unimpaired; (2) partial atrophy; or (3) total atrophy of the retina.

The *prognosis* of parenchymatous retinitis is always serious. The *treatment* is that for serous retinitis, with the addition of such measures as seem indicated.

Parenchymatous retinitis may be divided clinically into the following varieties: (1) leucocythemic retinitis; (2) diabetic retinitis; (3) albuminuric retinitis; (4) gouty retinitis; (5) symmetrical macular changes in infancy; (6) circinate retinitis; (7) solar retinitis; (8) punctate conditions of the fundus.—(J. M. B.)

Retinitis pigmentosa. PIGMENTARY DEGENERATION OF THE RETINA. This peculiar disease is not, strictly speaking, a "retinitis" but a degeneration of the optic tissues with atrophy of the retinal vessels and the accumulation and deposit of characteristic pigment in the substance of the retina. The disease is found in from 5 to 10 per cent. of deaf-mutes. It is sometimes attributed to consanguinity in the parents. The influence of consanguinity has been overestimated. Macnamara has shown that the disease is not infrequent among the Hindoos, whose religion prohibits intermarriage. It is also hereditary. It is not infrequent in idiots, in epileptics, in the victims of hereditary syphilis, and in families subject to nervous diseases. In many cases, however, the cause cannot be determined. The disease is either congenital or begins early in childhood, although the pigmentation is probably never present at birth. Retinitis pigmentosa is said by Leber to be more frequent in men than in women in the proportion of about 7 to 3. Other congenital anomalies are not infrequently present in cases of pigmented retina.

The *subjective signs of this disease* are (1) night-blindness, (2) loss of visual acuity, and (3) contraction of the field of vision. (See under **Perimetry**, on p. 9518, Vol. XII of this *Encyclopedia.*) The most noticeable subjective symptom is night-blindness: i. e., visual acuity is disproportionately lowered under reduced illumination. Often a patient who is unconscious of visual defect by daylight must

be led at dusk or on entering a dimly-lighted room. Night-blindness may be absent, and in rare cases, with retinal hyperesthesia, vision will be best in reduced illumination. Central vision may remain practically normal for a long time, yet perimetric examination will show there is reduction of the field. A ring scotoma, partial or complete, has been observed. Usually there is reduction in central vision in proportion to the contraction of the field. In exceptional instances good central vision is retained in the presence of great narrowing of the field. This contraction leads to loss of orientation. The patient sees as through a tube. The constant bowing of the head is characteristic. Occasionally color-blindness exists in these cases.

The ophthalmoscopic signs of pigmentary degeneration of the retina include changes in the vessels, in the optic disc, and in the retina. The vessels are contracted and their number is diminished. Their walls are thickened, producing a corresponding reduction in their lumen. Often they are so small as to resemble mere threads. The optic papilla is of a creamy-white color, usually not the dead-white of atrophy. The edges of the nerve are generally ill-defined and bordered with pigment, but the presence of pigment-spots on the nerve-head is very uncommon. The lamina cribrosa is usually hidden from view, and the whole disc looks waxy or transparent. The most striking of the ophthalmoscopic appearances is the presence of irregular pigment-spots, which are most numerous at the periphery and resemble bone-corpuscles in shape. They are usually more abundant on the temporal than on the nasal side of the fundus. Often the pigmentation is most abundant along the course of the larger vessels. Early in the disease the pigment-spots are situated in the far periphery, but as time passes they encroach upon the posterior pole. As the process extends the retinal pigment layer becomes decolorized, thus permitting a view of the choroidal vessels and giving the fundus a peculiar "wainscoted" appearance. Pari passu with the growth of the stellate pigment-spots atrophy of the retina and disc become manifest. Vitreous opacities are uncommon in this disease. Posterior polar cataract is occasionally seen, but less frequently than in choroiditis.

In typical cases *diagnosis* is not difficult. The pigment-spots do not always resemble bone-corpuscles, but may be rounded or irregular like the pigment collections found in choroiditis. That the pigment is in the retina is determined by the fact that the spots cover the retinal vessels. In the pigment accumulations of choroiditis the retinal vessels can be seen crossing the spots. Atypical cases of retinal disease have been described which present all of the subjective and

objective signs of retinitis pigmentosa except that the pigment-spots are absent. A few cases of unilateral retinitis pigmentosa have been described. Exceptionally the pigment-spots involve the macula, while none are found in the periphery of the fundus. A few cases have been recorded of glaucomá in eyes with retinitis pigmentosa. Blessig has reported the histories of nine brothers and sisters in whom these diseases alternated.

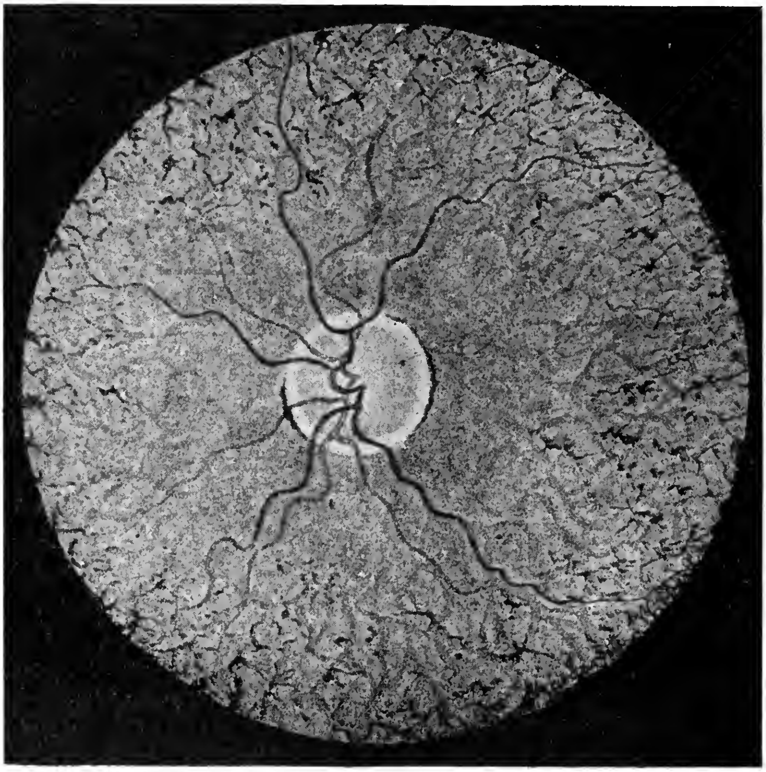
The changes are: an atrophy of the nervous structures of the retina, the nerve-fibre layer usually remaining. The supporting connective tissue becomes hyperplastic. In places the pigment epithelium atrophies; in others, it proliferates, invading all layers of the retina, especially the perivascular sheaths. Pigment granules may be seen scattered in the retina and are sometimes found occluding the lumen of a small sclerosed vessel. Where there is an atrophic area in the pigment layer, and sclerosis of the choroidal vessels is present, the retina will become adherent to the choroid. Drusen formations are a frequent accompaniment. Angiosclerosis is more pronounced in the arteries than in the veins, the smaller vessels being occluded by hypertrophy of the vessel-walls, many of which show hyalin degeneration.

Treacher Collins (*Am. Journ. Ophthalm.*, p. 425, 1919, believes this disease to be essentially an *abiotrophy of the retinal neuro-epithelium.* He points out that the pathologic examination of several eyes with retinitis pigmentosa had shown that the affection might occur without sclerosis of the choroidal blood vessels, and that the primary change appeared to be a degeneration of the rods and cones. As the condition is hereditary, he suggests that the degeneration might most aptly be described as an abiotrophy. From this standpoint, its various accompaniments might be explained as follows: The increase in the neuroglia of the retina is similar to that met with in various forms of neuronic abiotrophy, and not like what occurs in sclerosis where there is an increased firmness in consistency. Secondly, the pigmentation of the retina is caused by the degeneration of the rods and cones, together with their attached nuclei, leaving spaces in the membrana limitans externa, through which the pigment epithelial cells, or their pigment granules, can migrate. Such migration he considers was probably due to the physiologic capacity for movement in the direction of light, which these cells and granules possess.

The light-colored dots sometimes seen in the retina, and the hyaline nodules occasionally met with on the optic disc, are of the same nature; and are due to hyalin degeneration of cells derived from the outer layer of the secondary optic vesicle, from the pigment epithelium overlying the choroid, and the neuroglia in the optic papilla. In typical

eases the degeneration of the neuroepithelium commences where it is first fully developed; around the macula, which, being last developed, is last involved. This is why sight begins to fail in the form of a ring scotoma.

Night-blindness, the earliest symptom, is due to the failure of vision commencing in the part of the retina which, in the dark-adapted eye, is the most sensitive to light, that is 10° to 20° from the fovea. Typical



Retinitis Pigmentosa. (Ball.)

cases of retinitis pigmentosa occur in which the macula alone is involved. There being no blood vessels at the macula, there are, in these cases, no branching pigment patches, only scattered dots and granules of pigment. The deafness and affections of the nervous system met with in association with retinitis pigmentosa are also due to abiotrophy. See, also, p. 10221, Vol. XIII of this *Encyclopedia*.

The *prognosis* of this form of retinal disease is unfavorable, most of the cases ending in blindness by the time middle life is reached.

While total blindness is not the rule, vision is so much reduced that the patient needs assistance in getting about. Often, however, the disease remains stationary for long periods.

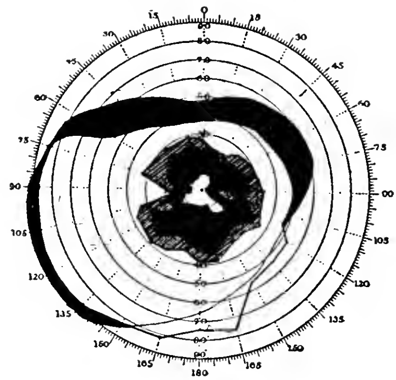
There is no cure for this disease. The best results of treatment are obtained in the form which is caused by acquired syphilis. In all cases of retinitis pigmentosa the eyes should be used in moderation and should be protected from excessive light. Errors of refraction should be carefully corrected. The frequent use of weak miotics, the internal or hypodermic administration of strychnia, and the employment of mercuric bichlorid are among the proposed remedies. Electricity in the form of the galvanic current applied to the eyeball has seemingly produced good results in some cases.—(J. M. B.)

Reuter (*Archiv f. Augenheilk.*, April, 1908) discusses *unilateral retinitis pigmentosa.* According to him only eight cases are on record, the first in 1865. The writer's case is that of a man of 65 in whom the right eye was quite normal while the left showed a condition of typical advanced retinitis pigmentosa with complete loss of sight. The history is important, as in the year 1882 he had been a hospital patient with iritis and synechiæ in the left eye, the fundus at that time showing no changes. Six years previous to that he had been under treatment for syphilis for six months. In the year 1899 he again came under observation, and at that time already had pigmentary changes and optic atrophy with nearly complete blindness of the left eye, which had since become absolute. It would add to the value of this paper, if the condition of the choroid were mentioned, but presumably the only changes visible in the fundus were those detailed, viz., optic atrophy, shrinking of the vessels and bone-corpuscle pigment. The rarity of this as a monocular condition justifies the publication of all similar cases. In this case the late onset and comparatively rapid course of the disease, and especially the fact that it followed undoubted syphilis, are noteworthy. Four out of the other eight previous cases showed signs of syphilis also, and in only two of them could syphilis be excluded.

In W. T. Shoemaker's monograph (*Retinitis Pigmentosa*, Phila., J. B. Lippincott Co., 1909), the author gives a complete account of the disease. He describes seventeen cases among the pupils of a deaf and dumb institution. He also made a careful investigation of the blood and urine of three patients, but with barren results.

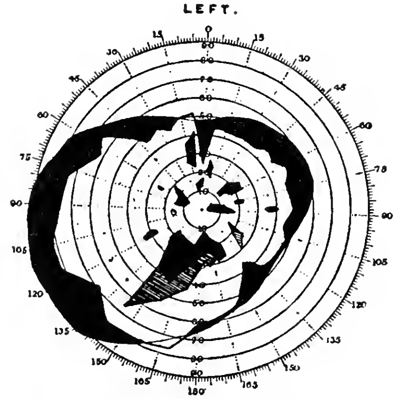
From the microscopic study of a case in which the retina had become detached, and iridocyclitis with pain caused the removal of the eye, Knape (*Oph. Year-Book*, p. 245, 1909), concludes that the predisposing cause of pigmentosa retinitis is an obliterating endarteritis

of the choroidal vessels, due to congenital tendency, and that the exciting cause may be some disease of the eye, a specific fever or syphilis. On the contrary Ginsberg, examining the eye of a man, first seen at the age of 24, and dying ten years later from tuberculous



Field of Vision in Primary Pigmentary Degeneration of Retina, Showing Ring Scotoma. (Hepburn.)

broncho-pneumonia, found over large areas of normal choroid the greatest changes in the retina. There was no relation between retinal and choroidal changes, so that disturbance of choroidal circulation



Field of Vision in Retinal Degeneration Secondary to Disease of Choroid, Showing Patchy Nature of Scotoma. (Hepburn.)

could not be considered a cause. He thinks the primary affection must be sought with the neuro-epithelium, probably an insufficient development causing failure to meet functional requirements and gradual destruction. Green reports a case of retinitis pigmentosa with

scanty formation of pigment masses. Nettleship makes extensive and important additions to his collections of family histories of retinitis pigmentosa, and congenital night-blindness without ophthalmoscopic lesions. In a family presenting Coppock family cataract (see p. 3316, Vol. V of this *Encyclopedia*), he found a series of cases of retinitis pigmentosa probably introduced in a different line of descent from the hereditary cataract.

The *Ophthalmic Year-Book* for 1912 has a number of short abstracts on this subject. The most important of these are as follows. The microscopic examination of an eyeball blind with this disease is reported by Greeves. The patient was a woman of 65, who had a severe attack of typhoid fever at 26, and 18 months later her sight began to fail. There was no consanguinity of her parents or grandparents. She was the youngest of thirteen children, and had a family of ten, of whom eight were still living. No similar eye disease had occurred in the family. The whole retina was atrophic, the rods and cones entirely absent. The macular region was least altered, all the other layers could there be distinguished. The vessels were all obliterated except in the posterior part of the retina, where they were reduced in number and size and had thickened walls. The membrane of Bruch was everywhere intact. The pigment epithelium formed a continuous layer at the macula and in the anterior part of the retina, and occurred in patches in the pigmented zone. The chorio-capillaris was only seen where there was pigment epithelium in contact with Bruch's membrane. But in the macular region it was not normal. The choroidal arteries had thickened walls. Greeves thinks the case supports the view of Gonin and Nettleship, that the choroidal vascular system is primarily at fault.

The eye examined by Suganuma had shown the typical appearances of retinitis pigmentosa, and was removed for hypopion ulcer, from a man aged 67. There was complete loss of the rods and cones, but some remains of the outer nuclear layer near the optic disc and at the fovea. The inner nuclear and ganglion cell layers were partly degenerated, the nerve fiber layer partly atrophic. At the posterior pole and the front of the retina the pigment epithelium was fairly intact. At the equator it was patchy. The choroid was slightly atrophic, a change supposed to be senile. The choriocapillaris was mostly normal, but in a few small areas was imperfect or absent. There was no sclerosis of choroidal vessels. Although the slight changes in the choriocapillaris seemed to support the view of Stock and Ginsberg that the disease is primarily an atrophy of the rods and cones, Greeves thinks the retinal vessels may be the primary seat of disease, or that

the disease of the vessels and that of the rods and cones are simultaneous, and due to the same cause.

Holloway reports the case of a patient, a man aged 34, who dated his ocular troubles from 9 years of age, when he had measles, having passed through scarlet fever three years before that. Three months ago he had severe pneumonia, and since had been unable to read. Vision was 5/40 and 5/30. Each macula presented the stellate exudate of albuminuric retinitis, while peripheral portions of the fundus showed typical appearances of retinitis pigmentosa. The urine contained albumin, specific gravity, 1006; blood pressure, 225.

Pöllot reports chorio-retinitis pigmentosa transmitted from the grandfather through his twin daughters, to two sons of each. One son of each daughter was slightly affected showing only hemeralopia and small scotomas. The other sons were more severely affected. Some of the pigment spots lay deeper than the retinal vessels, and there were several areas of choroidal atrophy.

A case of retinitis pigmentosa without pigment is reported by Shoemaker. The patient was a man of 26, whose visual fields were contracted to within 5 degrees of the fixation point, except that there was perception of large objects in the temporal periphery of both fields. The retinal areas were markedly contracted, but no abnormal pigmentation was discovered. The failure of vision dated from 6 years of age, following acute illness. Night-blindness was noticed from the age of 20.

Cases of *familial retinitis pigmentosa* have frequently been mentioned in this *Encyclopedia*. Marques L. Pons (*Archivos de Oftalm.,* Nov., 1912) reports a family in which three sisters were blind from birth. In each the fundus showed optic atrophy and characteristic pigment deposits of retinitis pigmentosa; in all three both eyes showed marked bulging of the cornea. The mother asserted that the corneal condition had been noticed shortly after birth in each sister. In two of them there was marked, in the other only slight, nystagmus. The patients were otherwise in good health and normal, and had never had any attacks of pain in the eyes. There was no consanguinity or history of eye disease in the ascendants, nor could evidence of syphilis be discovered. Two sisters had died in infancy, and one of these was said to have been blind. Another sister and a brother, who had both died in adult age, had had no disturbance of vision, and two living brothers had good eyes.

Carpenter reports three cases occurring in one family of five children. Two sons of the mother's brother gave a history of similar impairment of vision. The patients were boys of 16 and 18 and a sister

of 29. The boys had noticed impaired vision at 12 and 10 years, but suffered no night-blindness, and the younger had no pigmentation. The older brother showed the usual pigment deposits. The sister, affected from 6 years old, had night-blindness and extensive pigmentation. All showed ring scotoma and contracted visual fields. There was practically no evidence of choroidal disease. All gave negative Wassermann reactions, and there was no history of consanguineous marriages.

Oliver records a pedigree of thirteen cases in two generations, notable for the extent of the pigmentation, which reached almost to the optic disc at the age of 25. His impaired sight, when 8 years old, caused him to be taken to a doctor, who seemed to have recognized the condition at that time, and five years later noted that it was "a typical case." This patient was fifth of a family of four sons and two daughters, and all the others were healthy. The parents were first cousins. There was a trace of syphilis. On the margin of each optic disc were drusen, two in the right and six in the left eye. Fergus reports a case of advanced retinitis pigmentosa with almost complete blindness and peculiar subjective color sensations. This was in an unmarried woman, one of eleven children, of whom six survived. One brother also suffered from retinitis pigmentosa. The parents were first cousins. Other relatives had become blind.

Trephining in retinitis pigmentosa. Believing that any device or treatment that improves the retinal circulation will benefit vision, and bearing in mind the effect of the administration of amyl nitrite, subconjunctival injection and paracentesis of the anterior chamber M. S. Mayou (*Medical Press,* May 5, 1915), essayed the use of the trephine in retinitis pigmentosa. Doyne had shown that extraction of the lens was followed by immense improvement in vision, due, it was considered, to the fact that the patient is always in a condition of semi-daylight owing to the cataract, so that the retina did not receive sufficient stimulation. Mayou, while not denying this, thought that the lowering of the intra-ocular tension, with the consequent flushing of the retinal vessels, and the filtration of fluid through the scar, might be an additional factor, possibly the most important one, in the good result. He thought trephining would result in the retinal vessels being flushed with blood, and that the subsequent leakage might lead to a more rapid excretion of fluid from the eye, and drain away any toxic products which might be causing local vascular sclerosis.

He gives the history of a patient upon whom he did this operation and in whom there was much improvement in vision, lasting four and one-half months. The patient, Jewish, age 17, had complained of

night-blindness for two years; various relatives were similarly affected; there was marked pigmentation of the periphery, discs slightly gray, vessels practically normal in size; the fields were contracted to a 10° circle on both sides. Paracentesis resulted in distinct improvement in the fields. Trephining of the sclera of one side caused a reversion of the field to normal within a week and the patient could walk about freely in a darkened room; improvement continued to date (four and one-half months). On covering the unoperated eye she could see well at night; but if both eyes were open she was still somewhat night-blind; he could not advance any explanation of this. The improvement could not be expected to last very long; but it might continue for a length of time which justifies the operation, he thinks, in selected cases.

Removal of cataract in retinitis pigmentosa. Arnold Knapp (*Am. Journ. of Ophthalm.*, Oct., 1918), bearing in mind the observation of Doyne who was struck by the remarkable improvement in sight which followed the removal of the lens in cases of retinitis pigmentosa, reported four cases operated on for *cataract* with good visual results, vision being improved from 20/200 or less to 20/50 and 20/70, and from 3/200 to 15/200. The operation done was the ordinary cataract extraction, two of them having been extracted in the capsule. In each case the Wassermann test had been negative. There was no complication in the recovery after extraction of this form of cataract; and the results had been so favorable that he felt the operation should be urged upon the attention of ophthalmologists. There had been no improvement in the visual fields.

Herbert Harlan reported a case operated on about twenty years ago. The patient had long known that he had retinitis pigmentosa. He had consulted several oculists, and they all told him that he would eventually go blind, and that nothing could be done for him. His vision had become very bad. In walking on the street in the light, he could not see anything, such as a hole in the pavement. He had been training himself for blindness for years, so carefully that he was able to keep his position in the Pension Department through various administrations. There seemed to be no reason why the central cataract should not be removed, since it was shutting out the only vision he had. There was no difficulty about the operation. When glasses were adjusted, he had nearly 20/20 vision. He said that he had never before been able to see from the inside of the house the rain falling on the outside. A month afterwards, he came for an operation on the other eye. The operation was satisfactory; and the man still retained his central vision.

Retinitis pigmentosa centralis. This condition represents an atypical form of the disease. The pigment is not peripherally placed but is mostly confined to the posterior-central area. In these rare cases macular sight is lost while peripheral vision is preserved. The patches of pigment are sometimes quite large and they may be accompanied by small, round, whitish spots that are most numerous near the fovea. See, also, **Retinitis centralis punctata albescens.**

Retinitis pigmentosa sine pigmento. These are cases in which the cardinal symptoms of the disease are present, but without pigmentation. They are, in fact, instances of *congenital hemeralopia* in which the symptoms are stationary instead of being progressive.

Retinitis postica. Inflammation of the posterior retinal layer.

Retinitis proliferans. PROLIFERATING RETINITIS. HYPERPLASTIC (HEMORRHAGIC, RETINITIS. In this disease numerous bluish-white or gray masses of connective tissue develop in the retina and extend into the

Proliferating Retinitis. (Jaeger.)

vitreous humor. In a strict sense the affection is not a retinitis, but a proliferation of the connective tissue of the retina. The new tissue obscures the optic disc and often is disposed in interlacing bands. The cause is to be found in repeated and extensive hemorrhages into the retina and vitreous humor, the masses of unabsorbed blood producing atrophy by pressing on the retina and causing proliferation of connective tissue. The masses of newly-formed tissue may follow the general course of the retinal vessels, some of which lie under and others over the mass. There is often a development of new vessels in these cases.

The etiology of proliferating retinitis is unknown. Trauma and syphilis are supposed factors. The disease is rarely seen. Schöbel observed 2 cases in about 60,000 patients. The prognosis is unfavorable, blindness being the ultimate result. *Treatment* includes the use

of mercury and iodid of potassium by the mouth or mercury by inunction.—(J. M. B.)

de Schweinitz (*Ophthal. Record*, Sept., 1907), has reported one of the early cases. In this instance disease of the retinal blood vessels, retinal hemorrhages, hemorrhages into the vitreous and vascular veils were associated with lesions in the naso-pharynx and of the accessory sinuses demonstrated by means of the x-rays.

The ophthalmoscope revealed the following conditions: the optic disc was nearly round and had a small, central excavation. The veins were swollen, uneven and thickly coated with white tissue (periphlebitis). Between the branches of the upper and lower temporal veins and the upper nasal vein were extensive sheet-like hemorrhages and some areas of white exudate. The arteries in comparison with the veins were small and were also lined with white tissue indicating the infiltration of their walls.

Examination of the left eye showed a precisely similar, although less marked, condition of affairs—widespread disease of the vessels, with hemorrhages and exudates along their distribution.

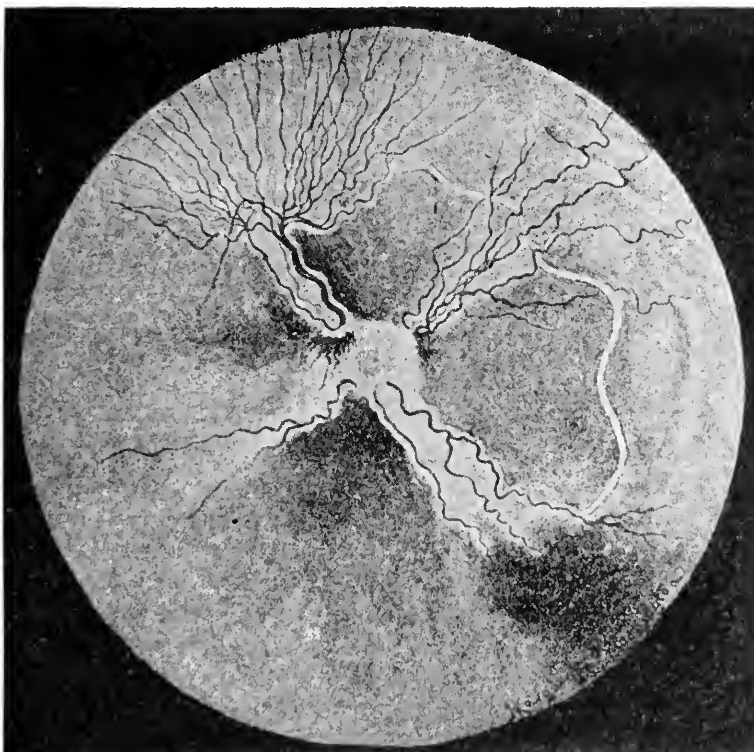
The nose showed some enlargement of the turbinals, especially of the lower turbinal on the right side. The lining mucous membrane of the nose was of a darker red than normal, due to chronic congestion. In the vault of the pharynx was discovered a large mass of adenoid tissue, not fibrous and pale with marked longitudinal furrows as is usually found, but soft with an even surface of a dusky red hue, due to chronic congestion. The faucial tonsils were very large and fibrous. The surface of the right one was traversed by dilated blood vessels. The pharyngeal and faucial tonsils were removed under cocain without difficulty, one at a sitting, bleeding being rather free.

A stereo-skiagraphic examination of the patient's head was made with the following results: the most prominent feature revealed by the x-ray examination was the abnormal development of the accessory sinuses of the respiratory passages. The frontal sinuses were enormous, and extended the entire width of the frontal region and well around into the temporal fossæ. Bony partitions were apparently lacking, and the walls were abnormally thin.

The sphenoidal and the ethmoidal sinuses were similarly affected, the chambers appearing greatly enlarged, and the walls thin, except the anterior and inferior wall, which apparently was decidedly thickened. Bony partitions were evidently present, but so thin as to make it appear that these two sets of sinuses merged one into the other.

Later, the vision of the right eye equaled hand-movements, there

was a small, central corneal scar, marking the position of a former disc-like infiltrate. On the surface of the lens were several clumps of iris pigment, but the pupil was widely dilated and there were no synechiæ. The vitreous was cloudy and the disc could not be seen. From in front and above the position of the disc and passing upward and forward, there was a large veil of bluish-white tissue carrying



Retinitis Proliferans, with New Vessel Formation; beginning Detachment of the Retina. Right eye. (deSchweinitz.)

on its surface congeries of twisted vessels, the surface of which could be studied with + 23 D. "Just below the disc there is a reddish mass indicating the presence of a hemorrhage, and also a larger, similar blood-carrying veil. On the nasal side there are large, sheet-like veils carrying similar twisted vessels and pressing forward + 17 D. into the vitreous. Passing from the top to the bottom of the eyeground on the nasal side there is a falciform stripe of glistening tissue somewhat in advance of the veils just described. Partial detachment of

the retina is evident. Vision of O. S. 2/150; cornea clear; no synechiæ; no pigment on lens.

"Beginning at a point approximately corresponding to the disc and occupying an extensive area of somewhat triangular shape, passing outward and downward, is a huge mass of whitish connective tissue supporting congeries of vessels and numerous smaller and larger hemorrhages. It is bounded above by a glistening band of tissue midway between the disc and the periphery, best studied with + 9 D., which joins on its nasal end with a similar smaller band passing upward and inward, and also with a band of like tissue which bounds the lower portion of the mass and which moves gradually around to meet the upper margin of the lesion. In the lower and inner portion of the eyeground and also carrying numerous twisted vessels are large, glistening, white masses, elevated + 9 D., and just to the nasal side of the disc and below are numerous sheet-like hemorrhages and large, glistening veils which extend to the periphery of the eyeground; in fact, the only portion of the retina which seems at all free exists upward and inward."

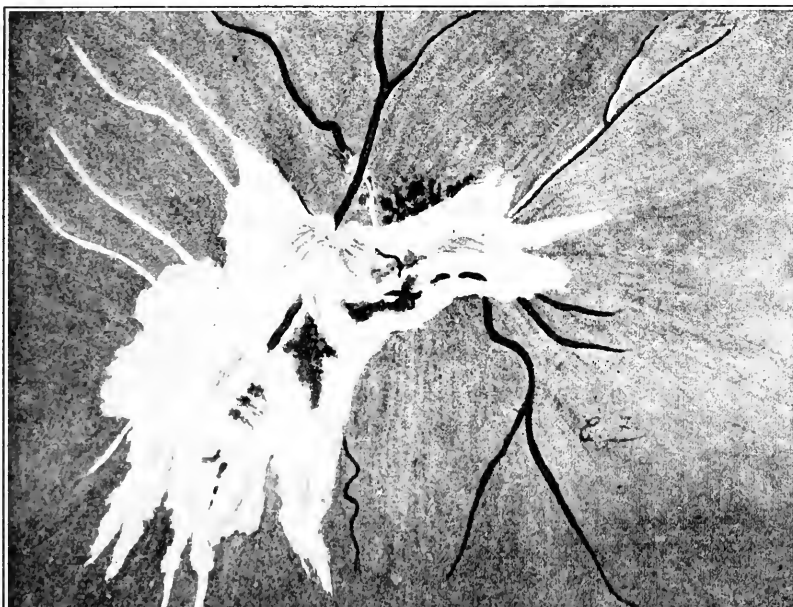
A slight prominence of the right eye continued, but there were no faults in movement except imperfect convergence, and no failure in the correlation of the movements of the eyelids and the eyeball.

P. C. Bardsley (*Ophthalmic Review*, p. 130, April, 1908), reports the case of H. H., aged 12, whose sight in the right eye had always been bad. There was no history of injury obtainable, and no difficulty was experienced at the birth of the child, and no instruments were used. At the upper part of the disc in the right eye is a large bundle of connective tissue stretching forwards into the vitreous on the temporal side, and the retina is detached; there are also a few strands to be seen on the nasal side.

From an anatomical study of 12 cases of proliferative retinitis, Harms (*Ophth. Year-Book*, p. 239, 1909), finds that in all cases it follows venous thrombosis with the organization of a pre-retinal effusion. Galezowski reports a case of proliferative retinitis in which the disk was hidden by new-formed tissue, from which bands extended forward to a peripheral mass that occupied the boundary of the ophthalmoscopic field. A woman aged 20, seen by Goldsmith, presented extensive retinal exudate which later assumed the appearance of renal retinitis. But the urine was found free from sugar or albumen and no hemorrhages were seen.

A rather anomalous example of retinitis proliferans has been reported by E. C. Ellett (*Prac. Med. Series*, Eye p. 130, 1910). The patient, thirty-seven years old, was a man addicted to the excessive

use of alcohol. Three years before the author saw him he had passed a kidney-stone and had had a hemorrhage from the intestines or kidneys—it is not certain which. Shortly after the bleeding he found the vision in the left eye was blurred. From this time onward changes were discovered in the background, as follows: Left eye. "The media are clear, refraction, low myopia. The disc is round, very pale pink with white vessel-entrance and blurred edges. A thick, pale crescent with pigmented edges is seen to the nasal side. Down and in at the edge of the disc some short pigment lines can be made out,



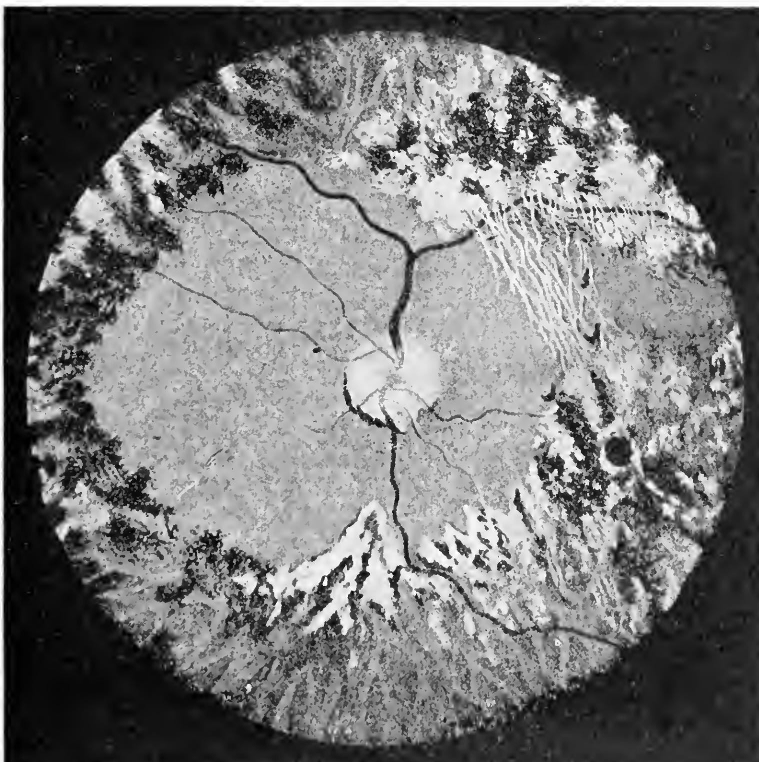
Proliferating Retinitis (Zimmerman).

which cover the retinal vessels as they leave the disc. All the retinal vessels are much narrowed and without reflex. The arteries are very narrow; only the larger ones can be traced off the disc, and they are soon lost. Following the apparent course of the descending nasal artery after its disappearance, a whitish band is seen to appear 2 d.d. from the disc, and is seen for ½ d. d. It is lined partly on both sides by a strip of black pigment. The descending temporal artery is more easily followed as a white, non- vascular band, to where it merges, down and out, with some of the white, lace-like formations to be mentioned. The temporal veins are given off only after the main trunk

has passed upward 1 d.d. from the disc. Just where this trunk passes from the disc it undergoes a distinct widening, evidently due to the pressure of a sclerosed and invisible artery. The appearance of the disc is that of post-neuritic atrophy. The most conspicuous feature of the eye-ground is a ring from one to three d.d. wide that surrounds the disc at a distance from it of from one d.d. nasally to two and one-half d.d. temporally. This ring is composed of two elements, first a whitish, lace-like formation, and, secondly, pigment. The lace-like formation is well described by the name, and looks as if a lace collar had been laid on the eye-ground around the disc. The apertures are more plainly seen on the side of the ring around the disc, and through them the normal red of the fundus shows here and there. In many places this has the appearance as if the white figures were pressed down on the fundus, which projects slightly into the apertures. The appearance of the white bands is as if they were drawn tightly and slightly contracted. This figure is at the level of the fundus, and in front of the vessels. Only a few of the vessels can be traced past the edge of it, and these are all veins. As has been mentioned one artery (descending temporal) becomes fibrous and passes directly into one of the white figures down and in. The inner, i. e., central, edge of the ring is in most places free of pigment, except nasally, and the space enclosed by the ring is practically so. Especially out, up and out, and down and out, the outer two-thirds of the ring is densely pigmented. The pigment varies from slate to black, and lies on the white, lace figure. The pigment is in general irregularly arranged, and obscures portions of the lace-work and the few vascular trunks that can be traced into it. In the pigmented areas the white figures are made to look whiter by contrast and lumpy and irregular by interruption of their visible portions. The characteristics of these white areas is more of an organized striated layer than the irregular masses of exudation seen in various forms of retinitis. In this respect the drawing is not exact. Nasally, the pigment advances more to the disc edge of the ring, and here strongly suggests the bone corpuscle figures of retinitis pigmentosa, but they are much less delicate. Except, as suggested, in the pigmented border of what appears to be the descending nasal artery the relation of the pigment to the vessel-walls so often seen in retinitis pigmentosa, cannot be made out. Beyond the limits of the ring, which are not sharply defined, the fundus shows in general a normal color, corresponding to that part around the disc. Numerous small, irregular scattered whitish areas, irregularly pigmented, can be seen over the whole

visible parts of the eye-ground. No retinal vessels are seen here, but the choroidal vessels show as light bands with dark interspaces."

Black (*Year-Book*, p. 208, 1916), describes a retinitis proliferans in a man of 25 years. The condition must have existed in the left eye at least 10 years while the trouble in the right eye was more recent. In the left eye the proliferation extended from the disk downward; and covered the disk completely, projecting into the vitreous 11 D.



Retinitis Proliferans with Pigmentation. (Ellett.)

The macula was free but vision was eccentric without any explanations for it. The right eye presented a hemorrhage in the vitreous, about 7 D. in front of the disk, with normal vision.

Retinitis, Pseudonephritic. RETINITIS STELLATA. Duane (Fuchs' *Text-Book of Ophthalmology*, p. 579), quoting Leber, remarks that in this condition there is a star-shaped figure at the macula closely resembling that of albuminuric retinitis, but it is not due to a nephritis. One form occurs in young subjects, may be unilateral, is without discover-

able cause and may be associated with a slight papillitis. The visual disturbances are slight, and eventually complete recovery takes place. In other instances, however, the onset is more acute, is preceded by severe headache and pains in the eyes and is accompanied by a marked neuroretinitis. These cases are helped by salicylic acid (q. v.). Other non-renal cases occur with syphilis, chlorosis, influenza, as well as with choked-disk, meningitis and hydrocephalus. Still other examples are found with attacks of sudden blindness, or sector-like defects in the visual fields; and these are generally due to embolism. Finally, it is seen in some cases of severe injuries of the skull from blunt force.

Retinitis, Punctate. GUTTATE RETINITIS. TAY'S CHOROIDITIS. The different varieties of this retinal disease will be found described under the specific captions following, and elsewhere in this *Encyclopedia.* Some of these changes, although spoken of as retinal, probably are confined to the tissues of the choroid or originate therein. See, for example, **Crick** (*not* "Crick's") **dots** (see p. 3560, Vol. V). *Metallic dots* are very brilliant, occur singly, look like minute deposits of metallic mercury and may appear in any part of the background. They are most frequently (Frost) observed in amblyopic eyes but are also found in normal fundi. The ophthalmoscopic appearance is believed to be due to a total reflection from their irregular retinal surface.

Isolated, neuritic dots are found in the foveal region, are chalk-white and of irregular shape.

Tay's choroiditis, sometimes called *guttate or punctate retinitis* is described on p. 2144, Vol. III of this *Encyclopedia.*

Punctate conditions of the retina are permanent and are not amenable to treatment.

Retinitis punctata albescens. Under this name Mooren first described the case of a man, 30 years of age, whose fundus presented hundreds of white spots distributed equally.

In this rare disease the spots are small and of white or yellow color, without pigment borders. They never coalesce, and are rarely found in the foveal region. The disease causes reduction in central vision, while peripheral vision is normal. Night-blindness is absent. The few cases which have been studied have mostly occurred in young subjects, and the disease has been found in several members of the same family. It is supposed to be either a congenital affection or one that develops in early infancy.

Nettleship has described a somewhat similar affection in which minute, white, round spots were scattered over the fundus and were associated with pigment changes at the periphery and with night-

blindness. They are known as Nettleship's dots. They are stationary or slowly progressive. Some authors have regarded this condition as a variety of retinitis pigmentosa, but this view is generally considered erroneous.—(J. M. B.)

Desiderio (*Annali di Ottalm.*, XLI, p. 66, 1914), has reported two cases of this affection which Antonelli regards as belonging rather to the group *punctate albinism of the fundus* of the eye with congenital hemeralopia (Lauber). They were met with in a lad of twelve years and in a girl of six years, the offspring of the same father, who was very alcoholic and who had died from tuberculosis. The little girl, in addition to her eye troubles (V.=1/3, marked hemeralopia) showed considerable arrest in her mental development and suffered from frequent epileptic crises.

Cohen (*Oph. Year-Book*, p. 211, 1916), gives the history of two colored children, a boy of 13 and a girl of 6, who had negative family history, the other four children in the family being well. The patients were otherwise well, the chief complaint being hemeralopia, no scotoma. The fields and central vision were greatly reduced by diminished illumination. Numerous grayish-white dots of different sizes, with ill-defined edges, began at the equator and spread downward to the periphery, leaving the posterior pole free. Vessels passed over the dots; no pigment changes.

Martha Diem (*Klin. Monatsbl. f. Augenheilk.*, 53, p. 371, 1916), reports this disease in a girl aged 18, whose father and father's brother had retinitis pigmentosa, whose grandmother had been blind and other members of the family had ocular affections. The patient presented diminished central vision and peripheral contraction of the visual fields. The macula was encircled by fine, yellowish-white spots. The periphery of the fundus also showed yellowish-white spots and accumulations of black pigment. Thus the case presented the rare combination of two different pathologic processes: retinitis punctata albescens and retinitis pigmentosa—a chronic atrophy of the retina, in which the degeneration set in at different parts of the retina in varying intensity.

Retinitis, Punctate diabetic. Sometimes the milder forms of retinitis in diabetes take the shape of white fundus deposits only. They are nearly always discrete and occasionally accompanied by hemorrhages. See **Retinitis, Diabetic.**

Retinitis, Purulent. Septic retinitis with formation of pus mostly takes the form of a *metastatic (embolic) purulent retinitis*, a *traumatic purulent retinitis (panophthalmitis)* or a *secondary purulent retinitis* following local and generally perforating processes, such as serpent

ulcer. All of these are fully described under the captions indicated.

Retinitis, Pyemic. A synonym of metastatic or embolic retinitis.

Retinitis, Recurrent. See **Retinitis, central relapsing syphilitic.**

Retinitis, Renal. Renal vascular retinitis. See, as an introduction to this section, **Retinitis, Albuminuric.** Among the contributions to a study of the retinitides most closely associated with renal changes are the following.

N. M. Semple (*Trans. Am. Oph. Soc.*, 1911; review in *Annals of Ophthalm.*, p. 504, July, 1912), discusses the method of development of the retinitis of Bright's disease. Uncertainty appears in regard to the changes in the kidney, as, for example, in the diseased kidney of pregnancy; it has not been settled whether they are chiefly degenerative or partly degenerative and partly inflammatory. As far as pathologic investigation has been able to demonstrate, the condition of the kidney occurring during pregnancy is of the acute diffuse or parenchymatous type, with rapid degenerative changes. The etiologic factor has not been definitely demonstrated. The most generally accepted theory is that of a severe toxemia, during the course of gestation. The kidney or the liver or the retina may bear the brunt of the attack, in certain cases the kidney escaping entirely, and many times the affected organ recovering rapidly after an early abortion. A case under consideration illustrates this. The patient, aged 28, four years previously had undergone an attack of retinitis during her first prenancy, which resulted in the complete loss of vision of her left eye. Two subsequent pregnancies had gone to full term without retinal complication. But during her fourth pregnancy the vision of her right eye began to fail early and proceeded rapidly to light perception only. The entire central portion of the retina showed extensive involvement. An intense edema, with large areas of exudation, showed the characteristic white appearance, and fringed by numerous hemorrhages, completely surrounded the disc, extending well beyond the macula. The other eye showed large atrophic spots bordered by heavy pigmentation, in the neighborhood of which areas of active inflammation could be seen. Artificial delivery of a full term child was immediately performed. The inflammatory condition of the retina promptly began to subside, but without improvement in vision. Repeated examination of the urine failed to show any involvement of the kidney. There seems to be no essential difference between the retinitis of pregnancy and that from other forms of Bright's disease, except the rapidity and intensity of the former, due probably to the increased virulence of the toxins in the blood. Immediate emptying of the uterus allows the active retinal inflammation to subside and the

exudate to absorb before any destruction of retinal tissue, with deposits of hyalin. The pathologic changes in this case, as in three others recently reported are essentially alike. They all represent such changes as take place in cases of comparatively short duration. Corresponding to the white areas as seen with the ophthalmoscope, were found masses of exudate confined chiefly to the outer reticular layer, but occasionally extending even to the external limiting membrane. The reaction of these masses to different stains gives a definite picture of fibrin in various stages of metamorphosis into hyalin. The retinal tissue itself is left practically intact. There were no traces of fat or of fatty degeneration of the supporting fibers of Mueller, in marked contrast to the findings of Leber. The changes described by him occurred in cases of longer duration. The changed ganglion cells of the ganglion cell layer are to be seen in those sections showing the most extensive involvement of the retina generally, and also there are found large deposits of fibrin and hyalin. They are in masses. The hyalin is evidently derived from the colorless elements of the blood and certain migratory cells. At first they appear swollen; in the more advanced stage they have lost their normal position and are found in the nerve fiber layer, are greatly swollen, losing all characteristics of the normal ganglion cells except that they retain a very noticeable similarity in shape to these cells. With the combined eosinhematoxylin stain the central body, representing the nucleus, stains an intense red, while the surrounding cell substance is tinged a light red. How these cells are transferred to their position may be understood by remembering that the edema causes extravasation from the outer and inner plexuses of the small retinal vessels, which extravasation eventually forms the hyaline masses in the outer reticular layer. From the inner larger plexus the first effect of the edema is naturally on the adjacent ganglion cell layer, the cells being pushed into the nerve fiber layer, becoming soaked with the albuminous fluid, eventually undergoing the hyaline changes before mentioned. Also, inasmuch as there are cases of marked involvement of the retina in Bright's disease where the retinal and choroidal vessels are practically normal, we may conclude that the most reasonable explanation for the development of the disease in the retina is that the toxins of the blood act as the direct offending agent, and this before affecting the vessels to an extent histologically demonstrable.

Schieck (*Oph. Year-Book*, p. 239, 1909), examined microscopically two cases, one being of parenchymatous nephritis which ran a rapid course. In both he found marked changes in the nervous elements of the retina, but no trace of alteration in the blood vessels. He sug-

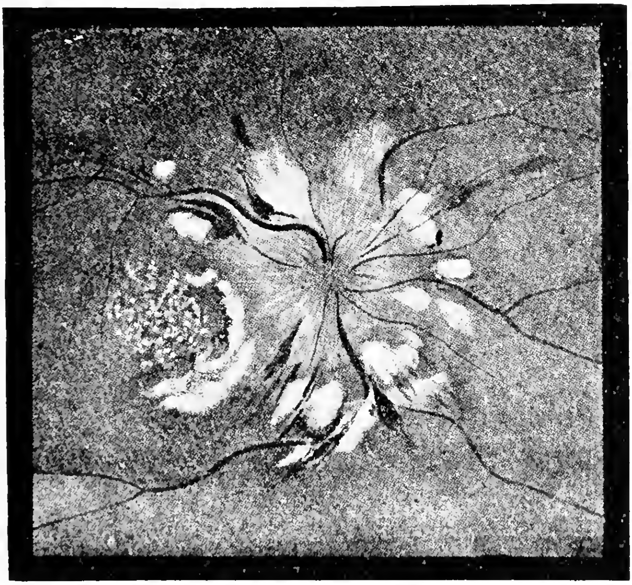
gests, however, that arterio-sclerosis probably favors the poisoning of the nerve elements by causing impaired nutrition.

Shiba has studied the renal retinitis associated with nephritis, produced in rabbits by injecting into the substance of the kidney a diluted tincture of iodine. In six out of nine animals subjected to the experiment, retinal changes were clearly demonstrable. But in none of these eyes was there any noticeable alteration of the vessels discovered. Shiba therefore is of the opinion that the direct cause of the retinal changes is to be found in some alteration of the state of the blood. Zur Nedden studied the relation between the retina and kidneys in the rabbit by introducing portions of the kidney of a rabbit into a dog and thus producing a serum toxic for the kidney of the rabbit. This nephrotoxic serum was injected into the rabbit. When introduced into the vein of the ear it caused a lesion of the kidney and death, with no pathologic changes in the eyes that could be demonstrated. But when injected into the common carotid there followed in two hours bluish-white superficial spots in the retina which reached a maximum in six or eight hours. Most of the animals died of the kidney lesions in two days; but in one that survived white, shining spots remained in the retina. Control injections of normal serum from the dog produced no pathologic effects. [The Editor makes in connection with the foregoing his usual protests against drawing any final conclusions in human ophthalmology from experiments on dogs, rabbits or other animals lower than the monkeys. Most of it is waste time—or worse.]

Parsons reports a case as possibly one of metastatic neuro-retinitis in which the appearances were those typical of renal retinitis, including the star-shaped figure at the macula; but the condition was confined to one eye and the urine was normal. Suker reports a case of large retinal and subhyaloid hemorrhages, and later hemorrhagic retinitis, in which repeated examinations at first failed to show albumin in the urine. Laidlaw emphasizes the liability of the characteristic degenerative changes of renal retinitis to occur with little or no albumin to be found in the urine and the consequent inappropriateness of calling the condition "albuminuric." In one of Shoemaker's cases, although diabetes had existed nine years, the retinal changes followed more closely the "albuminuric" type. Cases of renal retinitis occurring in children are reported by Lawson and Bloom. Gibson urges the importance of terminating pregnancy when renal retinitis supervenes.

Weill regards renal retinitis as a most important symptom of azotemia; the other early symptoms being torpor and lack of desire or

disgust for food. Of 194 patients with Bright's disease examined ophthalmoscopically, sixty-six showed retinitis; 33 per cent. of all cases, and 54 per cent. of the 122 cases that showed azotemia. In twenty-one of these cases the retinal condition first revealed the azotemia and nephritis. Of fourteen cases in which the retained urea was less than 1 gm., ten were followed to the end, the first dying in fifteen months, and the last in twenty-two months. Of four cases in which the retained urea was between 1 and 2 gm., all died between three and seven months. In three cases in which the urea amounted



Albuminuric Retinitis of Small White Kidney. (R. R. James.) *Oph. Review*, June, 1913.

to more than 2 gm., death occurred in five days, three months, and eight months.

The proportion of retinal involvement seems to be larger before middle life. Of Weill's cases forty-one occurred before 40 years of age and twenty-five after, eight occurring between 16 and 20 years. In discussing the significance of ocular findings in estimating longevity, Posey, bringing together the cases collected by Grönouw and Litten, finds 209 cases of retinal disease among 939 cases of disease of the kidneys, or 22.4 per cent. He states the average age has been found to be over 40 years, very few cases occurring before the age of

40, although he has seen a case in a boy of 12. Bulson says eye lesions are found in 40 or 50 per cent. of all cases of nephritis.

James (*Ophthalmic Review*, p. 63, June, 1913), tabulates twenty-four cases of "small white kidney" disease, eighteen of which were examined ophthalmoscopically and fifteen showed neuro-retinitis. In four cases the impairment of vision led to the discovery of the disease. He thinks that in some cases this lesion represents a late stage of the large white kidney; but in others he believes it is a distinct affection. It occurs in young adults; the oldest patient was 50, the youngest 16; and the majority between 25 and 35. The blood-pressure is always very high, and the retinal lesions more common and severe than in other forms of nephritis. The prognosis is unfavorable. The cases often get rapidly worse and die in a few weeks. A few temporarily improve, but rarely live more than a year.

Taylor has been struck with the short duration of life in some of his albuminuric cases, and the long duration in others. He has seen a patient dying within a few hours after the discovery of the retinal changes, and another living after five years. Ormond (*Oph. Year-Book*, p. 225, 1913), reports a case of retinitis with albuminuria in which the retinal lesions had called attention to the general disease ten years before. The vascular changes had been marked throughout, but there was little evidence of toxemia, and the renal function was still fairly good.

R. Foster Moore (*The Lancet*, Dec. 18, 1915), in writing of *renal retinitis in soldiers suffering from epidemic nephritis* (see the review in the *Ophthalmoscope*, p. 375, July, 1916), says (1) that of 119 soldiers from France suffering from epidemic nephritis, 5 were either the subjects of renal retinitis or the latter developed under observation. In addition, 7 presented very small retinal hemorrhages, very few in number, and not considered to be of any particular significance. (2) The average systolic blood pressure in 70 men with normal fundi was 143 mm., whereas that of the 5 men with retinitis was 180 mm. (3) In the case of the 5 men who developed retinitis, the intervals between the onset of symptoms of nephritis and the development of retinitis were approximately, 7, 8, 8, 13, and 9 weeks. (4) The retinitis which developed did not differ in appearance in any essential from the retinitis of chronic nephritis. In each of the men in whom it occurred the general symptoms were severe, and, in general, the more severe these symptoms, the more extensive were the changes in the retina. Retinal detachment occurred in 3 of the cases. (5) There is no doubt that the very great majority of the 119 men were suffering from a primary acute nephritis and were not the subjects of a previ-

ously existing chronic nephritis. In the case of the 5 men with retinitis a special effort was made to ascertain any evidence which might point to a previous nephritis. This was obtained only in 1 case (the author's statement about this case does not seem to the reviewer to be perfectly clear), in the other 4 there was no discoverable reason to suppose a previous nephritis. (6) It would thus appear at first sight that retinitis may occur in primary acute nephritis. But the author's previous experience is against this view, and he analyzes the cases with a bias in favor of bringing them into a chronic category. His words are:—"If now the present cases are considered with regard to this point, it will be seen that a very large majority have run the course of an acute nephritis, ending in temporary recovery without the development of retinitis. On the other hand, the course of the disease in some cases has been more progressive, and instead of improvement towards recovery occurring, the edema and urinary signs have persisted, the blood pressure has increased, and uremic symptoms have appeared. The acute disease has merged gradually into a condition of chronic nephritis, and it is in this group of cases that retinitis has occurred. It should be stated that some cases have run a more mild chronic course without developing retinitis; thus 2 men have been watched for 20 and 21 weeks respectively, and although symptoms persist the fundi are normal. It would seem then that strength is lent to the view that retinitis does not occur in primary acute nephritis, but that when this gradually and directly merges into a condition of chronic nephritis, retinitis may coincidentally develop. In this latter case the signs of retinitis may be seen as early as wthin 7 weeks (Case 1) or 9 weeks (Case 5) of the onset of symptoms of the acute disease."

West takes issue with Moore about the use of the terms chronic nephritis and renal retinitis, since the term chronic nephritis is used in parenchymatous nephritis and in granular kidney. According to West albuminuric retinitis exists in two forms—the exudative and the degenerative. The first is the same as that usually understood by the term acute optic neuritis and is like the one seen with cerebral tumor; it may occur with acute and chronic parenchymatous nephritis. The degenerative form shows typical glistening white patches and is pathognomonic of granular kidney. See, also, **Nephritis, Eye symptoms of,** p. 8308, Vol. XI of this *Encyclopedia*.

Retinitis, Saturnine. While in most cases of chronic lead-poisoning (which may present ophthalmoscopic changes similar to those of albuminuric retinitis) albuminuria is present, exceptional cases have been observed by Förster, Rosenstein, and Lehmann. The diagnosis

between albuminuric and saturnine retinitis must rest on the following data: (1) the history of the case with special reference to the patient's occupation; (2) the presence of a blue line on the gums in case of lead-poisoning; (3) the finding of lead in the urine.—(J. M. B.) See **Plumbism,** p. 10290, Vol. XIII of this *Encyclopedia.*

Retinitis, Septic. See **Retinitis, Metastatic.**

Retinitis serosa. See **Retinitis, Simple.**

Retinitis serosa centralis acuta. See **Retinitis, Central.**

Retinitis, Serous. Edema of the retina. See **Retinitis, Simple.**

Retinitis, Simple. Serous retinitis. Retinitis serosa. Edema of the retina. This condition is characterized by a limited or general opacity of the retina; by increased size and turtuosity of the vessels, particularly of the veins (which may be somewhat obscured by the retinal edema); and by diminution in visual acuity in that part of the field of vision which corresponds to the diseased area. Hemorrhages are not often found in serous retinitis. Distortion of vision may be present. Thus, objects may appear too large (megalopsia) or too small (micropsia). The patient may see better by reduced illumination or toward evening (nyctalopic retinitis of Arlt). The disease may be unilateral or bilateral. It may be caused by trauma (retinitis from concussion), by eye-strain, or by certain constitutional conditions (syphilis), or may be due to unknown causes. Other forms of retinitis may begin as serous retinitis, and will naturally be classified as such until their special features become demonstrable. The papilloretinitis accompanying sympathetic ophthalmitis is of the serous variety. Although ophthalmic writers have treated of several varieties of serous retinitis, we will here consider only one form: syphilitic retinitis.

The diagnosis of serous retinitis must rest on the ophthalmoscopic findings, the absence of appearances characteristic of the parenchymatous and embolic forms of retinal inflammation, and the history of the case. The blurring of the fundus found in astigmatism and the haziness due to fine vitreous opacities are sometimes causes of errors in diagnosis.

The prognosis of serous retinitis is favorable.

The treatment will include removal of the cause, the correction of errors of refraction, the local use of atropin and smoked glasses, and attention to the general health. The correction of constipation, indigestion, etc., is of importance. A patient with serous retinitis should not be kept in a dark-room, nor, on the other hand, should he be exposed to bright light.—(J. M. B.)

Retinitis, Solar. Retinitis due to exposure to excessive sunlight.

Workers with powerful arc lights or electric furnaces, as well as those exposed to the fierce light of the sun (as in watching an eclipse) should wear deep-ruby, dark-amber or other sufficiently tinted glasses, lest their eyes be permanently damaged by a central scotoma which may correspond to a genuine, organic lesion of the papillo-macular fibres. When the symptoms (scotoma, dazzling, etc.), appear after exposure the eyes should be well shaded, atropia instilled and the case treated as one of central chorioretinitis.

Tyson (*Year-Book*, p. 213, 1916) saw a man of 42, who after viewing an eclipse with the naked eye, noticed a red ball in front of him; with (later) inability to see small print. With the ophthalmoscope a small, circular disk of exudation could be seen in each macula resembling an optogram of the sun. Under treatment vision became 20/20. In the discussion similar cases were reported. Tyson finds a stenopaic slit or hole an aid in detecting central scotoma for distance; figures are better than letters for near. See, also, **Retinitis from excessive light**; as well as **Eclipse amblyopia**, p. 4127, Vol. VI of this *Encyclopedia*.

Retinitis, Specific. See **Retinitis, Syphilitic.**

Retinitis, Splenic. Leukemic retinitis. The variety seen in leukemia, marked chiefly by hemorrhages into and paleness of the retina. See p. 7439, Vol. X of this *Encyclopedia;* as well as **Retinitis, Leukemic.**

Retinitis stellata. See **Retinitis, Pseudonephritic.**

Retinitis striata. Striate retinitis. In this condition the retina shows yellowish-white or grayish lines which may run in almost any direction, but often pass from the periphery toward the disc. The lines lie beneath the retinal vessels and frequently are branched. They are sometimes found in spontaneously cured cases of retinal detachment. Their cause is not known. Caspar considers the disease the final stage of reattached retinæ, while Holden regards it as due to changes following retinal hemorrhages. Vision usually is much reduced in these cases. The condition does not admit of treatment.—(J. M. B.)

Retinitis, Suppurative. See **Retina, Suppuration of the.** This may be a primary condition, due generally to septic embolism (see **Retinitis, Metastatic**), or it is still more frequently one manifestation of panophthalmitis. In the former instance the ophthalmoscope shows retinal hemorrhages and yellow-white exudates that soon end in general cloudiness of the fundus, including the vitreous, and, at last, the picture of purulent panophthalmia. The prognosis is gloomy, and not uncommonly both eyes are affected. For treatment see **Panophthalmitis**, p. 9230, Vol. X of this *Encyclopedia.*

Retinitis sympathica. Retinitis of sympathetic origin, usually occurring in the course of a sympathetic iridocyclitis with vitreous opacities, but sometimes primarily. It is attended with marked retinal hyperemia, redness of the disc, engorgement of the veins, and great disturbance of vision. See **Sympathetic ophthalmia.**

Retinitis, Syphilitic. LUETIC RETINITIS. SPECIFIC RETINITIS. SYPHILITIC CHORIORETINITIS. This disease is sometimes serous, sometimes parenchymatous. The question of the existence of an inflammation of the retina, caused by syphilis and independent of choroiditis, has been much discussed by eminent ophthalmologists. In recent years the question has been decided in the affirmative. The condition known as diffuse syphilitic choroidoretinitis, the diffuse syphilitic choroiditis of Förster, is characterized by the presence of fine, dust-like opacities in the posterior part of the vitreous, blurring and redness of the optic papilla, and by alterations in the macular region and in the vessels.

The *diffuse syphilitic retinitis of Jacobson* is a later secondary manifestation of syphilitic infecton, appearing six months to two years after the primary infection. The disease, however, may result from hereditary syphilis. It may be unilateral, but usually is bilateral. Other forms of syphilitic retinitis which have been described by competent observers are: (1) *relapsing syphilitic central retinitis,* (2) *syphilitic hemorrhagic retinitis,* (3) *syphilitic arteritis of the retina,* and (4) *syphilitic perivasculitis of the retina.* The first of these is a rare disease which is characterized by relapses and by ophthalmoscopic signs limited to the macula. Vision is often suddenly reduced, but improves markedly during the intervals, although after repeated attacks it may be permanently diminished. The macula looks gray or grayish-yellow, and may show small, white points arranged in groups. Pigment-spots appear after the disease has lasted for several years. Micropsia has been noticed in these cases, and sometimes the disease passes into diffuse syphilitic retinitis.

Syphilitic hemorrhagic retinitis, also a rare affection, is characterized by opacities in the posterior part of the vitreous humor and by numerous hemorrhages of various sizes and shapes. The arteries are small, and the veins are enlarged and tortuous.

In syphilitic arteritis of the retina the arteries appear as narrow gray or white bands and finally disappear, the pathologic process being an endarteritis obliterans. The veins are enlarged. The cerebral arteries in most cases are involved in a similar obliterative inflammatory process. In many of the cases few retinal symptoms are present; the vision is not much reduced; opacities in the vitreous, redness

of the nerve-head, and blurring of its margins are not marked; and night-blindness is absent.

Syphilitic perivasculitis of the retina, also known as syphilitic periphlebitis of the retina, has been described by Scheffels. The papilla is red; the veins are enlarged and tortuous, and are surrounded by dark-red hemorrhages. The arteries may be normal and the retina transparent.

Nagel found localized adhesions between the choroid and retina. About these points of adhesion the choroid was degenerated, the choriocapillaris being entirely destroyed. Usually the retinal changes are more advanced than those of the choroid, but the reverse may be true. The outer layers of the retina are destroyed at many points, while the inner layers show masses of irregularly arranged pigment. Müller's fibres are thickened, and the blood-vessels show marked inflammatory thickening. There are many points of similarity between the anatomic changes of specific choroidoretinitis and those of retinitis pigmentosa.

The *diagnosis* of these conditions must be made ophthalmoscopically and by attention to the patient's history or by the finding of other syphilitic lesions. The Wassermann test is of value. The exclusion of other causes of retinitis will aid in the diagnosis.

Syphilitic retinitis is a chronic disease, although at times the onset is sudden. The *prognosis* will depend largely upon the time at which treatment is begun. Under energetic use of proper remedies great improvement can be expected; but when treatment has been delayed there are likely to be grave retinal and choroidal lesions, with corresponding loss of vision.

Treatment. The use of mercury by inunction or by the mouth is of the highest importance. In appropriate cases the intra-venous injection of arsphenamin will be in order. At the same time attention should be given to the digestion and nutrition. The eyes may be protected by dark glasses, and in the acute stage a mydriatic may be used. In the later stages the use of iodid of potassium is to be advised.—(J. M. B.)

See, also, the captions **Syphilis of the eye** and **Retina, Syphilis of the.**

Retinitis, Tay's infantile. Amaurotic family idiocy. See **Tay-Sachs disease.**

Retinitis, Traumatic. COMMOTIO RETINÆ. See, in particular, **Retina, Injuries of the** and **Retinitis centralis atrophicans.** This subject is also discussed under **Retinitis, Purulent,** as well as on p. 2517, Vol. IV of this *Encyclopedia.*

Retinitis with massive exudation. See **Retinitis, Exudative.**

Retinochoroiditis. Chorioretinitis. Retinochoroiditis in general. Inflammation of both retina and choroid. Many forms of inflammation primary in the choroid sooner or later affect the retina and this fact is taken for granted by some authors who speak, for example, of a *choroiditis disseminata*, *choroiditis areolaris*, etc., that should more properly be designated a chorioretinitis or a retinochoroiditis. When the retina is implicated the ophthalmoscopic signs proper to such involvement are present in addition to the choroiditic indications. The former are mainly cloudiness of and hemorrhages into the retinal tissues, followed by pigment deposits in and atrophy of the retina.

For a study of those choroidal inflammations that involve the retina see the various **Choroid** and **Choroiditis** headings.

Retinochoroiditis centralis. See **Choroiditis, Central,** p. 2140, Vol. III of this *Encyclopedia*. In addition, it may be said here that the symptoms include the early recognition by the patient of a cloud before the point (or area) of fixation, due to an exudate into the macular region. This blurring of central vision is all the more marked if the foveal obscuration is due to a sudden hemorrhage. In either case the perimeter maps out a positive central scotoma. Eventually, after absorption of the blood, the site of the clot is occupied by a whitish, atrophic spot. In high degrees of myopia as well as in some other fundus conditions the place of the round, central, post-hemorrhagic area is occupied by a variously-shaped (often pigmented) figure extending from the macula to the disk. This band-like formation seems to follow the line of the fetal cleft.

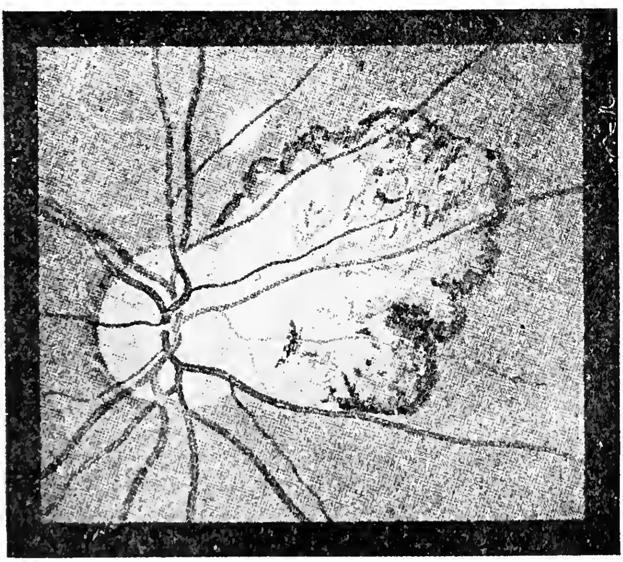
As a rule, the *prognosis* is quite unfavorable; the organic changes in the affection are not improved by any remedy, except, perhaps, in certain luetic cases. The *treatment* depends upon the cause of the central disturbance. Pilocarpin injections, iodides, mercurials, dark glasses, entire rest of the ocular apparatus and local blood letting are all recommended.

Retinochoroiditis juxtapapillaris. Choroiditis *vel* retinitis juxtapapillaris. Jensen's disease. Edmund-Jensen disease. In 1909 Edmund-Jensen (*Archiv f. Ophthalm.*, 69, I) applied this title to four cases of retino-choroiditis occurring in the near neighborhood of the disc. The patients were all young and apparently perfectly healthy, with no evidence or history of syphilis.

The ophthalmoscopic picture showed a white, oval swelling about the size of the disc and in contact with it. The retinal vessels in the situation of the swelling were more or less obscured by it. The vitreous usually showed some opacities. The field of vision in every case showed a blind sector extending outwards to the periphery and cor-

responding at its apex with the position of the swelling. The central vision was not affected except to a slight extent from the vitreous opacities. The patients were kept under observation and the swelling slowly subsided, so that at the end of two or three months only a somewhat pigmented, scarred area remained. The defective sector in the visual field was permanent.

One patient had a recurrence of the inflammation at the same spot as the original attack 2½ years later, and a third attack 5 years after the second. Jensen, in discussing the cause of the condition, points out the obvious explanation of the relationship of the swelling to the

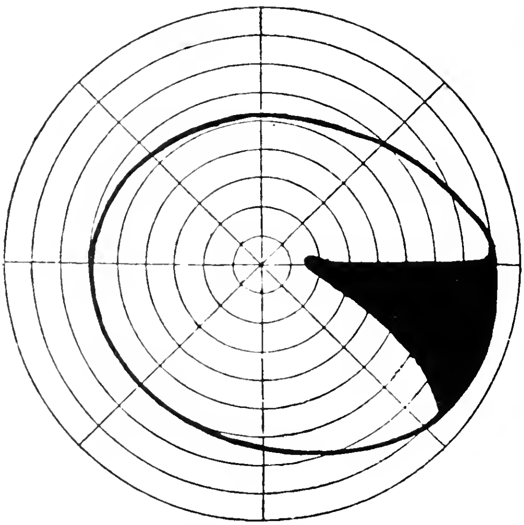


Eye Ground in a Case of Retino-Choroiditis Juxtapapillaris Causing a Sector Defect of the visual field. (Edmund-Jensen.)

defective section in the visual field, viz., that the latter is due to an obliteration of a branch of the arteria centralis. In his opinion the vascular disturbance is a secondary condition due to pressure by the swelling on the underlying arterial branches. After the swelling had subsided the vessels then exposed were seen to be very small but they were not obliterated and blood appeared to be still circulating. If the obliteration of the arterial branch is considered to be the primary disease a more diffuse edema of the retina would result and not a small, localized swelling, also after subsidence the vessels would appear as mere threads. The condition was met with only four times in ten years out of about 26,800 patients.

The reviewer in the *Oph. Review* (p. 320, Oct. 1909) thinks that Jensen's theory is the correct one, that the swelling causes so much interference with the arterial circulation that the retina supplied by the vessels involved becomes functionless. He does not suggest the possibility that all of these cases are instances of solitary tubercle.

In a case reported by Cunningham (*Oph. Year-Book*—p. 236, 1909) the optic disk was entirely surrounded by the area of inflammation, and the sector defect in the field which extended upward also involved the fixation point in one eye, and in the other there was a large absolute scotoma which did not extend quite to the periphery of the field. Vision was reduced to 1/60 in each eye.



Field of Vision, showing Sector Defect in a Case of Jensen's disease.

Petersen (*Klin. Monatsb. f. Augenh.*, August, 1912) reviews fifteen cases reported in the literature as similar to the condition described by Edmund-Jensen, in 1908. He finds that the disease occurs between the ages of twenty and thirty-five, in otherwise healthy individuals, and is characterized by hazy vision, associated with a small cotton-like lesion, having a predilection for the papilla. In some cases a string-like opacity springing from the lesion has been noted. The visual fields show defects which are sharply defined and explained by Petersen as due to lesions in the nerve fiber layer. A striking feature of the disease is its proneness to recurrence in the vicinity of earlier lesions; but in the face of this the prognosis is good. Petersen considers this as evidence against the disease being of tubercular origin.

Syphilis is apparently of no consequence in the etiology. Petersen comes to the conclusion that the disease has its seat in the retina, as the destruction in the choroid is not at all so severe as in disseminated choroiditis. The writer believes that the etiology is still much in the dark, and will probably remain so until an opportunity arises to examine a case histologically.

A. W. Ormond (*Ophthal. Review*, p. 384, Dec., 1912) reported the case of a man, aged 20, who found, on awaking, that he could not see very well with his right eye. He had a little pain in the eye a week previously. On examination there was found keratitis punctata, and a patch of acute choroiditis touching the upper margin of the optic disc, and spreading upwards. Edema of the retina spread over and beyond the patch. Vessels which passed over the inflamed area were partly obscured, and the arteries diminished in size; there was also some haze in the vitreous. von Pirquet's reaction was positive. The inflammation gradually subsided, and the patient had full visual acuity, but a large sector of his field of vision, stretching from the blind spot to the extreme periphery, was entirely absent, and he had no perception of light in this area. The defective area in the field of vision was clearly due to the obliteration of a branch of the central retinal artery by the pressure of the inflammatory swelling.

A. L. F. Apleman (*Ophthal. Rec.*, May, 1914) reports an example of this rare disease. P. M., aged 21, came on account of slight blurring of vision and slight pain in his left eye. This had appeared three days previously, with pain near the inner canthus, extending upward to a point in the forehead just above the brow—not radiating. He stated that the blurring seemed to be increasing since he first noticed it. He gave no history of lues or other infection. The urine examination was negative.

Without glasses, vision equaled 5/6 in each eye; improved to normal by glasses.

Upon ophthalmoscopic examination the writer found the media clear. The disc was swollen + 3 D., and its edges were obscured. The swelling extended into the retina above and to the temporal side, gradually blending with the normal retina in the neighborhood of the macula. The swelling was white at its thickest part just off the disc, and gradually diminished towards its periphery.

The vessels were hidden by the swelling of the retinal fibers, the veins being engorged and tortuous. Slightly above the macula, four small, parallel, radially disposed hemorrhages were seen.

An examination of the visual field revealed an absolute scotoma

involving the area of the blind spot and extending over a portion of the nasal field; it involved practically the whole nasal field.

In the course of the following week vision was reduced in the affected eye to 5/21, probably in part due to fine vitreous opacities which appeared about this time.

Treatment consisted in the use of hot compresses locally, and 1 per cent. atropin solution. Sweating by means of hot packs given daily, followed by inunctions of mercurial ointment to the point of salivation, and later the administration of potassium iodide. By these measures the inflammatory condition began to improve, as did his vision.

The scotoma in the visual field extended gradually until it involved practically the entire nasal quadrant, probably due to degeneration of the nerve fibers involved in the inflammatory focus.

At the time of the report the man showed an area of degeneration near the disc, up and out, with some pigment heaping, involving an area about half the size of the disc, although there had been little choroidal absorption. The disc edges were fairly distinct. The vitreous opacities had disappeared, and the visual acuity was 5/6, improved to 5/5 with correction.

At the first examination, the ophthalmoscopic picture led to suspicion of neuroretinitis.

The visual field, it should be remembered, is of prime importance in deciding this point; the most important and most constant change in neuroretinitis being a concentric contraction of the visual field, enlargement of the blind spot and formation of scotomata. In localized choroiditis, the visual field shows a scotoma corresponding to the portion of the fundus involved, the course of the inflammation being relatively benign, and the loss of central vision practically is *nil* unless the macula be involved in the process.

As to causative factors of this condition, disease of the accessory nasal sinuses should be thought of. In this case, there was no evidence of such involvement and examination proved negative.

The possibilty of a toxin giving rise to localized inflammation had been suggested.

H. H. Martin (*Journ. So. Med. Ass'n.*, p. 455, June, 1918) recently examined 17 cases (9 males, 8 females) of varying ages. Each complained of nebulous vision. Only four complained of pain in the ciliary body. In two of these, iritis was actually present. In thirteen cases, the external eye looked normal. In every case there were opacities in the vitreous. In nine patients the site was exclusively beside the papilla. In every case the papilla was normal.

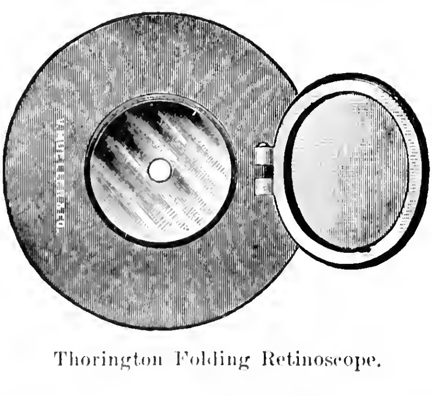
The writer believes that the defect originates in the nerve fibers, as the result of their obstruction by inflammation. A relapse does not modify the original defect. Every case relapses, or will relapse in time. A single acute attack lasts from one to four months.

The prognosis is good, in a way. The patient sees normally. He still has a field defect, and is sure, as stated, to relapse. The treatment is rest in bed and aspirin. Latent tuberculosis looms up prominently as a cause. For the destruction of nerve fibers, this disease would have to be so extreme that no examination of the eye-grounds would be possible. There was no evidence of tuberculosis of the eye in any of these cases.

Martin maintains that the name now given this disease should not be retained, because the inflammation may be in the periphery. He would term it Jensen's disease. He thinks that infection of some sort is responsible; and that the retina, especially near the papilla, is especially sensitive to this infection. One should examine the visual field in every case of choroiditis, especially near the papilla. In his cases, the inflammatory focus was central and single, began in the deeper layers, was sharply limited and appeared to follow the course described by Jensen, and the cloudiness of the vitreous persisted long after the inflammation had begun to subside under treatment. Repeated Wassermann tests in his cases were negative. The choroidal disease was secondary to the retinal. All possible focal infection should be eliminated.

Retinopapillitis. Inflammation of the retina and the optic papilla.

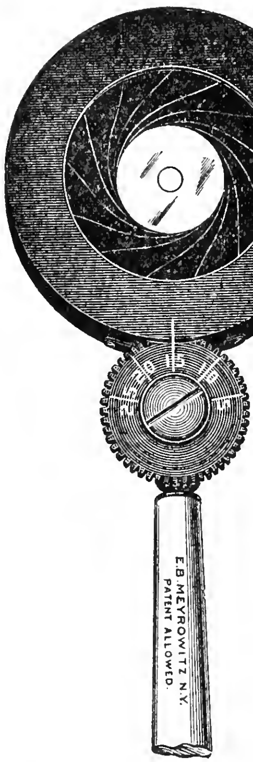
Retinophotoscopy. An unused synonym of skiascopy.

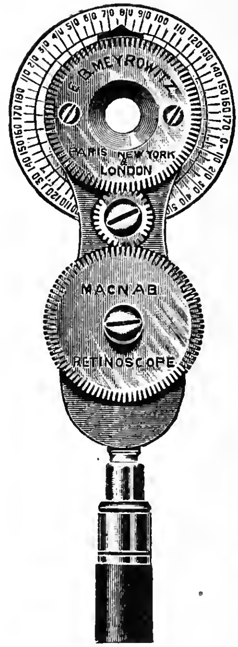


Thorington Folding Retinoscope.

Retinoscope. SKIASCOPE. UMBRASCOPE. Instruments for performing retinoscopy have already been described and pictured under several captions in this *Encyclopedia*—especially on p. 4723, Vol. VI. It may

be added here that most ophthalmoscopes are provided with mirrors intended to be employed in skiascopy (q. v.). Frequent additions to the separate devices are also constantly made. Among the latter are the Thorington "folding" retinoscope (see the figure); the Harris "iris diaphragm" retinoscope (illustrated); and the Macnab "automatic" (consult the cut). In the last-named instrument (the invention



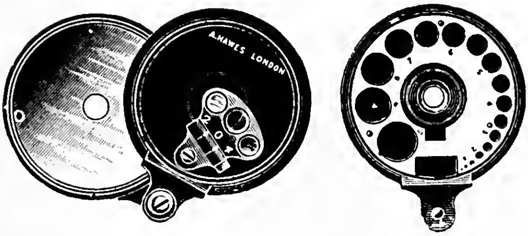


The Harris Iris Diaphragm Retinoscope. The Macnab Automatic Retinoscope.

of Angus Macnab) the mirror, instead of being plane or spherically concave, is cylindrical, and the effect on the illuminated area of the fundus is to produce a band of light instead of an image of the lamp. By means of milled wheels the mirror is allowed to rotate and the band of light on the fundus can be made to lie in the axis of the astigmatism when such is present. After a little practice the location of the axis can be made to within five degrees, a matter of importance in examining young children.

Bradburne's (*Oph. Record,* Mar., 1908) double mirrors are hinged

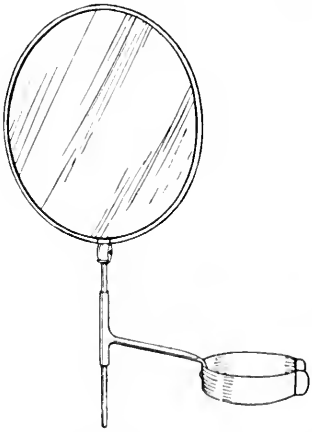
together for protection and fitted with a triangular carrier behind the sight hole. This carrier is fitted with a + 2 D. and + 4 D. lens, and a center hole which is unglazed. They can be rotated at will over the sight holes of the mirror, and are of advantage because of in-



Improved Retinoscopic Mirror. (Bradburne.)

creased magnification. They also lessen the distance at which the observer has to stand from the eye of the patient.

Retinoscopic lamp shade. A useful accessory (known by the trade name of the Chloros retinoscopic lamp shade) is depicted in the text. When fitted in front of the light source it forms a shield against the ultra-violet rays, and prevents undue fatigue of the patient's and the surgeon's eye during retinoscopy.



Chloros Retinoscopic Lamp Shade.

Retinoscopy. Skiascopy. Umbrascopy. Determination of the refractive state of the eye by observing the movements of lights and shadows across the pupil when light is thrown out through the eye into the retina from a moving mirror. A description of this valuable

method will be found under **Examination of the eye,** p. 4718, Vol. VI; and as a subsection of **Physiological optics,** p. 9916, Vol. XIII of this *Encyclopedia*. The reader is, however, referred to the major heading, **Skiascopy.**

Retinoscopy, Phosphenic. A term given by Serres d'Uzes to a process for ascertaining the condition of the retina when the lens is opaque. Slight pressure is made on different regions of the closed eye, and, if the part of the retina pressed is healthy, a luminous circle or arc (phosphene) is seen by the patient on the side opposite to the point of pressure.

Retinoskiascopy. Same as **Skiascopy.**

Retinula. One of a small group of nerve-end cells joined by chitin, constituting rhabdoms, behind a lens in the eye of an arthropod, varying according to whether it is a simple or a compound eye. See p. 2531, Vol. IV of this *Encyclopedia*.

Retouching-desk or -frame. A framed sheet of ground glass, adjustable at any angle, used in retouching negatives.

Retraction of the globe. The eyeballs do not retract within the orbital cavity under normal conditions. The chief causes of retraction are forcible closure of the lids, spasm of the recti muscles, action of a congenitally abnormal choanoid muscle (see p. 2072, III, as well as under **Comparative ophthalmology** in this *Encyclopedia*), atrophy of the orbital tissues and excision of the superior cervical ganglion.

H. Grimsdale (*Oph. Review*, p. 340, Nov., 1909) reports a case of globar retraction on blinking. The patient complained of occasional double vision, and that the movements of the eyes were somewhat strange. The vision in each eye was 6/9, with + 1 sph. Movements in all directions were free except upwards, and in this direction the eyes rotated 15° and then stopped. On blinking there appeared to be retraction of the eyes, and if the lids were held open actual retraction was very evident, as if all the muscles were thrown into spasm; some of the facial muscles were also spasmodic. There was marked optic neuritis of cerebral type, the swelling being about 5 D. Urine normal.

Robert Salus (*Archives of Ophthalm.*, Jan., 1913) points out that retraction movements of the eye may be due to different causes. The congenital form is not at all uncommon and is caused by a purely muscular anomaly, such as either a congenital aplasia of the external rectus, or a far posterior insertion of the internus.

Acquired retraction movements are much less common, and may be divided into four groups: 1. Comparatively common. Cicatricial adhesions following inflammatory processes or injury of the muscles

in the orbit, usually combined with enophthalmos and restriction of mobility. 2. Cases in which psychic emotions cause reflex contractions of the ocular muscles with short retraction movements. Salus has often observed retraction, especially during the removal of foreign bodies from the cornea. This retraction is momentary and spasmodic, and 2 to 3 mm. in extent. 3. An obscure group in which enophthalmos apparently occurs when the lids are drawn apart. 4. In this group lie those cases of retraction movements in which the cause is to be found, not in abnormal musculature, but in the central nervous system.

Salus discusses a case reported by Koerber, in which divergent strabismus developed with paresis of the internal rectus and superior oblique. On attempting to look upward there were retraction movements of both eyes and other signs. Koerber supposed that the condition was due to a disseminate sclerosis or chronic polioencephalitis superior.

A second case of Koerber's developed paresis of several branches of the third nerve following influenza. When he looked upwards there were marked retraction movements of the eyes. These were due, he believed, to an abnormally increased innervation of the recti, which occurred when the patient attempted to use the paretic elevator of the eye.

In his third case, that of a man 25 years old, there developed a somnolent condition following months of severe headache. Vomiting had been present. Left palpebral fissure was wider than right. On attempting to look in any direction there were marked retraction movements of both globes, spasmodic and jerky. Choked disc was found. Examination disclosed a cysticercus in the region of the fourth ventricle. The seat of the lesion was undoubtedly in the floor of the aqueduct of Sylvius.

Tyson (*Oph. Year-Book*, p. 93, 1913) presents a case of retraction of the globe on attempted adduction in a girl of 10. There was divergent strabismus of the left eye and enophthalmos of the right. On testing motility of the eyes to the right, the right eye came forward and the palpebral fissure widened, while the left eye turned in with intermittent nystagmoid movements. In looking straight forward, the right eye tended slightly upward and was retracted, with narrowing of the fissure, while the left eye tended to diverge with horizontal nystagmoid movements.

In looking to the left, the right eye retracted about 3 mm., tending slightly upward, the fissure becoming narrower. The left eye turned well upward. On attempted convergence the same movement oc-

curred in the right eye when it was fixed, the left diverging. The writer finds the best explanation for the upward and downward turning of the eyes in a consideration of the position and insertion of the fibrous band and opposing muscles and their lines of traction with varying amounts of innervation.

According to the views of John Green (*Trans. Amer. Acad. of Ophthal. and Oto-Laryngol.*, 1913) the choanoid muscle causes retraction of the globe. He then gives the acquired causes of retraction in man, after which he mentions a congenital anomaly (Duane's syndrome) (p. 4086, Vol. VI of this *Encyclopedia*), the features of which have been summarized by Duane himself as complete (less often partial) absence of outward movement in the affected eye; partial (rarely complete) deficiency of movement inward of the affected eye; *retraction in adduction;* oblique movements up and in or down and in, in adduction; partial closure of the eyelids of the affected eye in adduction; paresis or marked deficiency of convergence, the affected eye remaining fixed while the sound eye is converging.

After commenting on the fifty-four cases collected by Duane and published in 1905, Green adds four of his own. He is inclined to the opinion expressed by Duane and shared by Birch-Hirschfeld, "that in general an operation is not required and is to be avoided when possible." There are instances, however, where he believes operative procedure would seem to be rational, and an instance is given of a young girl, without the power of adduction since two years of age, who obtained an adductive power of 30 degrees by having the superior and inferior recti muscles split and the temporal halves inserted at the line of attachment of the external rectus muscle.

Zentmayer (*Am. Journ. of Ophthalm.*, March, 1919) describes a case of globar retraction on adduction in a boy aged five years. At the age of seven months the mother noticed that the left eye "rolled about in the head," and says that this has persisted. With eyes in primary position there was a very slight narrowing of the palpebral fissure on the left side. The right was normal.

In looking to the left the outward rotation of the left eye was limited. In looking to the right the left became retracted, a distinct space could be seen between the inner surface of the lower lid and the globe, and the palpebral fissure became distinctly narrowed. If the fixation was a little higher than the horizontal plane instead of the eyeball rotating strongly inward in adduction, when it reached a point just to the inner side of the middle line the eye shot strongly up. If fixation to the right was a little below the horizontal plane the adduction was increased, but no supraduction occurred.

The fundus was normal and the refraction error was a low H. + As., against the rule. Turk's theory probably best explains this symptom-complex. His view is that the retraction is due to inflexibility of the external rectus muscle of the eye. The oblique movements of the globe Duane attributes to spasmodic contracture of the inferior oblique. Parker attributes the closure of the fissure to some peculiar associated movement produced by synergic action of the facial and oculomotor nerves.

Retraction of the upper lid. A case of this almost unique condition is reported by Anton Lutz (*Anales de Oftalmologia*, Dec., 1912). The patient was a man of 27 years. The anomaly had been definitely noticed at the age of five years, and was probably congenital. Fundus and pupillary actions were normal. There was slight ptosis of the right eye, and a moderate weakness of the right superior oblique. The other ocular movements were entirely normal, and the position of the eyes had no influence on the anomalous feature of the case. This consisted of a marked retraction of the right upper lid, sometimes occurring on opening the mouth, but always provoked by lateral movement of the lower jaw to the left. The patient also had the power of voluntarily retracting the right upper lid without the accompaniment of other movements, the mouth being kept shut. This power of voluntarily producing the abnormal movement distinguishes the case from all similar ones hitherto reported. The writer assumes a supranuclear location for the central defect controlling the anomaly, probably in the posterior longitudinal bundle or the optic thalamus.

See, also, **Jaw-winking,** p. 6713, Vol. IX of this *Encyclopedia.*

Retractor bulbi oculi. The choanoid muscle. See **Comparative ophthalmology,** p. 2614, Vol. IV of this *Encyclopedia.*

Retractor, Eyelid. A metallic retractor employed in holding the lids up or down and away from the eyeball for examination or for operating. The usual pattern is that of a metallic plate fitting the inner surface of the lid and the outer surface of the eyeball. See **Lid retractor,** also *infra.*

Retractors. These mechanical devices serve various purposes in ophthalmic surgery.

The Desmarres retractor is the most widely known; among the other models are those of Stevens, Walton and Noyes.

A. E. Prince's instrument (*Ophthalmic Record*, Jan., 1907, p. 19), is provided with two fenestrated loops. One is the retractor; the other extends forward beyond the retractor and serves to depress the superior flap while the cornea is pressed upon below by the spoon.

A lid retractor (*Trans. Amer. Oph. Soc.*, 1874, p. 215) was devised

by H. D. Noyes to deal with an eye deeply sunken in the orbital cavity. It is made of stiff wire and is attached to the shank by two branching bars. These bars are bent at a little more than a right angle to the shaft which enables the operator to carry the whole lid under the orbital roof.

Ernest Moraweck has invented a wire lid elevator (*Ophthalmic Record*, May, 1908, p. 243) which is $5\frac{3}{8}$ inches long. The hook is of No. 14 and the fingering of No. 15, Brown & Sharpe gauge, tempered steel wire, nickeled, all parts hard-soldered.

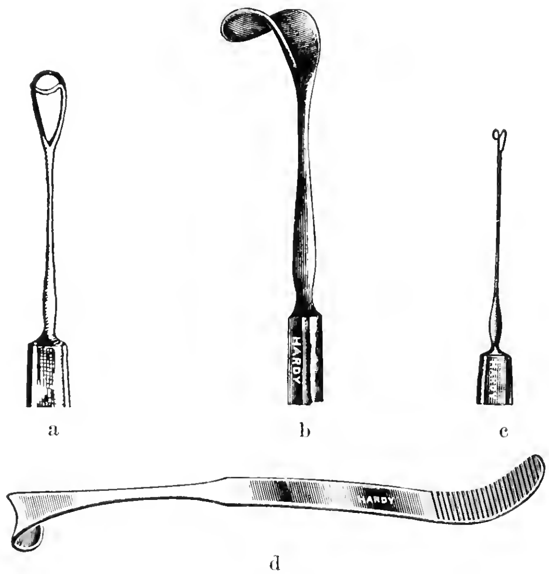


Fig. 169.

Retractors. a. Cataract (lid), b. Desmarres' (lid), c. Graefe's (lens), d. Fisher's (lid).

W. E. Baxter (*Ophthalmic Record*, Aug., 1901, p. 413) has devised a nickeled wire loop with a large retractor at one end and a small retractor at the other.

Cruise's retractor guide for sclerectomy is depicted in the text.

A number of *lachrymal sac retractors* are also described and pictured on p. 6972, Vol. IX of this *Encyclopedia*.

Finding the *lachymal sac* retractors in use too cumbersome, and with a desire to have a much smaller and lighter instrument, Glen Campbell (*Ophthal. Record*, March, 1916) has devised a modification of Wilder's for opening a scleral wound. It weighs only $56\frac{1}{2}$ grains. V. Mueller & Co., of Chicago, have made the mechanism for opening

and closing the branches in a simpler manner than is used in the Wilder instrument.

See, also, p. 7456, Vol. X of this *Encyclopedia*.

Retrobulbar. Situated or occurring behind the eyeball; retroocular.

Retrobulbar neuritis. ORBITAL OPTIC NEURITIS. RETOOCULAR NEURITIS. RETROBULBAR OPTIC NEURITIS. AXIAL OPTIC NEURITIS. ACUTE AXIAL NEURITIS (Wilbrand and Sänger). Inflammation of the orbital portion of the optic nerve may occur as an acute or as a chronic process. Owing to the location of the lesion, the ophthalmoscopic signs are either slight or not characteristic. After the neuritis has subsided the optic-nerve head will show atrophy.

Cruise's Guide-Retractor for Sclerectomy.

Four-pointed Sharp Retractor.

Acute retrobulbar optic neuritis is the fulminant form of retrobulbar neuritis and is of rare occurrence.

Among the causes are rheumatism, gout, syphilis, tuberculosis, exposure to intense cold, and infectious diseases (influenza, etc.). It has been seen to follow typhoid fever, carcinoma of the stomach, poisoning by the bite of a scorpion (Gonzales), lead-poisoning, and diabetes. Vail has observed retrobulbar optic neuritis in cases of intranasal disease with involvement of the sphenoid bone. The disease may follow facial paralysis, the optic neuritis occurring several months or years after the involvement of the facial nerve. Alveolar abscess, by causing orbital periostitis, may produce the disease. Orbital cellulitis is also a cause. Some patients with disseminated sclerosis show great loss of vision without marked ophthalmoscopic signs, one eye

usually being affected. In this disease bilateral involvement is more frequent in the form of chronic retrobulbar optic neuritis.

The symptoms include sudden diminution or obscuration of sight, beginning in the center of the field and leading rapidly to great loss of vision or to complete blindness. In some cases the papilla is swollen and both eyes are affected, thus resembling the intra-ocular optic neuritis which is associated with intracranial disease. In such retrobulbar cases the changes in the disc are not gross, and there is an absence of other symptoms of intracranial disease. Orbital pain and tenderness are present in this form of retrobulbar neuritis. However thorough the restoration of vision may be, the optic disc in cases of retrobulbar neuritis shows evidence of the past attack, in the form of pallor of the temporal half of the nerve-head. Blindness may appear in from one to eight days. Headache or dull pain in the orbit is generally present. At first the ophthalmoscope shows nothing pathologic; but later the nerve-head becomes hyperemic, the margins are blurred, the surrounding retina is hazy, and, in rare instances, small retinal hemorrhages and grayish or yellowish spots of exudation appear in the macular area. The arteries may be diminished in calibre, while the veins are enlarged and tortuous. Movement of the eye, or direct backward pressure upon it, will cause pain. Pain is limited to the diseased side and is unaccompanied by vomiting. Occurring in cases of acute or subacute myelitis, there may be marked swelling of the nerve-head. Obviously the line between intra-ocular and retrobulbar optic neuritis is sometimes an arbitrary one. After weeks or months signs of atrophy of the optic disc appear. Usually only one eye is involved. If the second eye becomes affected, there is generally an interval of months. Visual acuity is worse in a bright light. Patients often complain of seeing objects as through a moving haze. Dimness of sight may be complained of where vision is 6/6; and color-scotomata may be found. As a rule, vision is reduced to one-fourth or one-third the normal. With the decline of the acute symptoms, the ophthalmoscopic evidences of optic-nerve atrophy become manifest.

The changes include atrophy of the nerve-fibres, increase of the nuclei, and thickening of the trabeculæ and of the walls of the small vessels. Gunn states that pallor of the optic disc occurring subsequent to retro-ocular neuritis does not necessarily mean atrophy of the nerve-fibres, but may be due to increase of connective tissue secondary to lymphatic obstruction.

The disease is to be differentiated from suddenly discovered congenital amblyopia and from hysteric amblyopia.

Acute retrobulbar optic neuritis runs a rapid course, which ends

either in complete or in partial recovery. Recovery of useful vision is possible if improvement begins early. Nettleship believes that the affection may be a forerunner of spinal-cord disease. In favorable cases vision will become normal. In unfavorable ones there will be a central scotoma. Since the disease may cause blindness, a guarded prognosis should be given.

Where possible, treatment must be carried out according to the etiology of the disease. Rest of the eyes and the energetic use of diaphoretics will be advisable. If rheumatism is regarded as a cause, salicylate of sodium should be given.

Chronic retrobulbar optic neuritis (toxic amblyopia). This may follow repeated acute attacks, or the disease may be chronic from the beginning.

Among the causes are rheumatism, gout, exposure to cold, periostitis, meningitis, disseminated sclerosis, systemic poisoning with drugs, and heredity. The cases which are due to poisoning with drugs are classified as instances of toxic amblyopia and are discussed elsewhere in this *Encyclopedia.*

There is gradual reduction in visual acuity, with the presence of a central scotoma. The ophthalmoscopic findings may be negative or there may be pallor of the temporal segment of the optic disc. The symptoms are more fully considered under **Toxic amblyopia.**

Prognosis is favorable, provided the cause can be removed before atrophy of the nerve-fibres ensues.

Treatment is the same as that for toxic amblyopia.—(J. M. B.)

The etiology of retrobulbar neuritis, studied in 176 cases, is discussed by K. Langenbeck (*Archiv f. Ophthal.*, p. 226, Vol. 87). Multiple sclerosis was found in fifty-eight cases, 33 per cent.; suspected in fourteen, 8 per cent.; chronic, idiopathic (hereditary) affections, thirty-two, 18 per cent.; lues, thirteen, 7 per cent.; affections of the posterior nasal sinuses, six, 3.5 per cent.; sudden loss of blood, five, 3 per cent.; menstrual disorders, four, 2.3 per cent.; pregnancy, three, 1.7 per cent.; lactation, three, 1.7 per cent.; diabetes, four, 2.3 per cent.; traumatism, four, 2.3 per cent.; articular rheumatism, one, 0.6 per cent.; "cold" one, 0.6 per cent.; etiology unknown, thirty-six, 20 per cent. The frequency of multiple sclerosis surpasses even the statistics of Fleischer, who found it in 66 per cent. of his selected material. In 12 per cent., multiple sclerosis existed previously to the visual disturbances, in 20 per cent. these were observed simultaneously with the general symptoms. In 15 per cent. the affection of the optic nerve occurred before symptoms of disseminated sclerosis set in. When retrobulbar neuritis is not due to ectogenous intoxication it is (with a

probability of from 30 to 40 per cent.) an early symptom of multiple sclerosis. If it is not an idiopathic or hereditary form and if lues, diabetes, affections of the nasal accessory sinuses (which eventually show an enlargement of the blind spot) and the rare influences connected with orbital processes, anomalies of menstruation, gravidity, lactation, acute loss of blood can be excluded, then in more than 75 per cent. of the cases the cause is multiple sclerosis. Characteristic ocular symptoms pointing to an existing or imminent multiple sclerosis are nystagmus, the successive affection of both eyes after a long interval, the relapses, ocular palsies especially under the aspect of associated paralysis, and Uhthoff's sign of aggravation of the visual disturbance after physical exertion. If retrobulbar neuritis is combined with two of these symptoms, the early diagnosis of a nervous affection is probable, and this nervous disease may not develop for years.

Lindemeyer (*Klin. Monatsbl. für Augenheilk.*, p. 495, 1906) has described a *retrobulbar neuritis after burns of the skin.* A healthy laborer, aged 19, sustained, by explosion of a benzine lamp, burns of the first and second degrees of the dorsal sides of both hands, the lower two-thirds of the forearms and of the face. After two or three weeks he complained of pain in both eyes, especially when moving them. This disappeared after a week, but his sight commenced to fail. Seven weeks after the accident Lindemeyer found the borders of both discs indistinct, temporal halves slightly pale, vessels normally filled. At the right upper margin of the disc, several small retinal hemorrhages, at the upper temporal quadrant of left disc a hemorrhagic dot. Finger counting in each eye at 1 m. Central, absolute scotoma for white and colors; visual fields not contracted. Under diaphoresis, iodid of potash in large doses and subconjunctival injections of salt solutions, V. R. rose to 1/xv; V. L. to 1/xxxv.

Mooren, who first called attention to these affections, observed bilateral optic neuritis after superficial burns of both legs. Generally the retina is chiefly affected in the form of hemorrhagic retinitis. Most cases give a favorable prognosis with regard to restoration of vision, probably because the optic nerve is scarcely involved.

In this case the author considered the prognosis bad, on account of the retrobulbar neuritis which had descended to the optic disc. As it corresponded exactly with the type which we generally observe in intoxications, the author ascribes the etiological connection with the burns of the skin to a toxemia.

An attack of the disease ending in atrophy of the optic nerve, *following childbirth,* is reported by Kipp (*Prac. Med. Series*, Eye, p. 106, 1907). Whitening of part of the eye lashes and eyebrow of the same

side, after repeated gestation, was also observed by the writer in this case. He concludes that the pregnancies cause a disturbance in the vascular supply, a congestion at or near the apex of the orbit, pressure on the optic nerve and its sheaths and on the branches of the ophthalmic branch of the fifth nerve. Whitening of the lashes has been observed in severe iridocyclitis of sympathetic origin. In this case only the hairs in the line with the supraorbital nerve were affected. The change in color took place in the course of a few days. A second case of neuritis is reported in which recovery took place. Vision returned to 6/5 and color fields were complete, although the ophthalmoscope showed marked atrophy of the papilla without any change in the caliber of the retinal vessels. Iodid of potassium in 10-grain doses had been given for six weeks. There was no sugar or albumin in the urine.

The important question of prognosis in retrobulbar neuritis is discussed by Marx (*Archiv für Augenheilk.*, Dec., 1907), and the writer reports on 16 cases of retrobulbar neuritis seen by him during the attack and seen again at periods varying from a few months to seven years afterwards. In almost all the cases the onset of the attack was acute, and the vision of the affected eye had fallen to 6/60 or less. In periods varying from two weeks to two months there was almost complete recovery of vision. The ophthalmoscopic appearance of the disc after recovery was in four cases normal, in seven there was pallor on the temporal side, and in five the whole disc was pale. In six cases where the nervous system showed no signs of disease at the time of the attack, symptoms of multiple sclerosis subsequently developed, so that although the prognosis as to sight in these cases is as a rule good, that as to general health must always be guarded. The ages of the six patients who subsequently developed multiple neuritis were all between 19 and 23.

Holden (*Oph. Year-Book*, p. 560, 1909) reports six illustrative cases and comes to the conclusion that non-toxic retrobulbar neuritis commonly arises from inflammation of the accessory sinuses of the nose, or is a symptom of multiple sclerosis. In the latter connection it is of diagnostic value in distinguishing between paresis and multiple sclerosis. In 70 cases of early paresis, not complicated by tabes, he found no case of lesion of the optic nerve. Of patients suffering from multiple sclerosis about one-half have disturbances of vision, which usually appear early, and of these more than one-half have central scotoma from retrobulbar neuritis.

Fleischer investigated the subsequent histories of 30 cases of retrobulbar neuritis, in which no other cause for the neuritis could be assigned. He found that 6 of them showed other symptoms of multiple

sclerosis at the time of the neuritis. Of the remaining 24 one could not be re-examined, and 20 had subsequently developed symptoms of multiple sclerosis. In addition Fleischer records 12 cases of acute neuritis with decided swelling of the optic nerve entrance, of whom 5 developed symptoms of sclerosis. He thinks that in acute retrobulbar neuritis not due to toxic influence or extension of the inflammation as from the adjoining sinuses, especially in a young person, we are justified in the diagnosis of incipient multiple sclerosis.

Bagh reports 4 cases of retrobulbar neuritis in which multip'e sclerosis subsequently developed, the general symptoms appearing in one of the cases only after a lapse of ten years. In another case the ocular symptoms determined the diagnosis between hysteria and organic disease. In two cases reported by Hoge this diagnosis also rested on the discovery of the evidences of optic atrophy. Schley also reaches the conclusion that disease of the optic nerve, in young persons without other discoverable cause, should be regarded as evidence of impending sclerosis.

Siegrist reports a case of retrobulbar neuritis without discoverable cause. But only 5 months had elapsed since the onset. Balint has investigated the connection of retrobulbar neuritis with disturbances of the sensory roots of the spinal nerves. In 22 cases, 12 ascribed to alcohol, 6 to tobacco, and 4 to both, he found most frequently affected the roots of the eighth cervical and first dorsal, then those of the third, fourth and fifth dorsal, and, somewhat rarely, the fifth lumbar and first sacral.

Schleich, among 25 cases of retrobulbar neuritis, had been able to follow 15 for some time, of whom 4 had developed multiple sclerosis. He believed that this could not be excluded with less than ten years observance of such a case. He also emphasized the connection of the neuritis with disease of the nasal accessory sinuses. In the discussion of his paper other cases illustrating the connection of retrobulbar neuritis with those two conditions were reported. Wagenmann reports a case of bilateral complete amaurosis from retrobulbar neuritis, followed after some weeks by complete recovery of central vision, but with concentric contraction of the visual field.

Krauss (*Oph. Record*, May, 1909) reports a case of retrobulbar neuritis due to ethmoiditis. There was concentric contraction of the fields with central scotoma of the right eye. Removal of the middle turbinal, and straightening the septum was followed by restoration of vision to normal in both eyes. Risley reports 3 cases of optic neuritis due to sinus disease, 2 of which were cured, while the third improved after removal of polypi and of part of the middle turbinal, but became

entirely blind from optic atrophy after a recurrence of nasal disease.

The relation between arteriosclerosis (q. v.) and chronic retrobulbar neuritis has been discussed under several captions of this *Encyclopedia.*

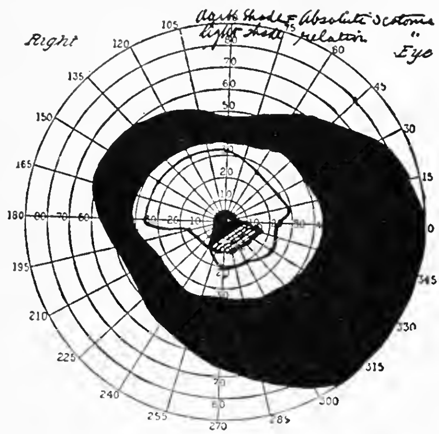


Fig. 1. Krauss's Unilateral Retrobulbar Neuritis due to Ethmoiditis.

Scalinci's (*Oph. Year-Book,* p. 259, 1912) clinical observations have forced him to the conclusion that there is a definite relationship between abnormal conditions of the cardiovascular system, and

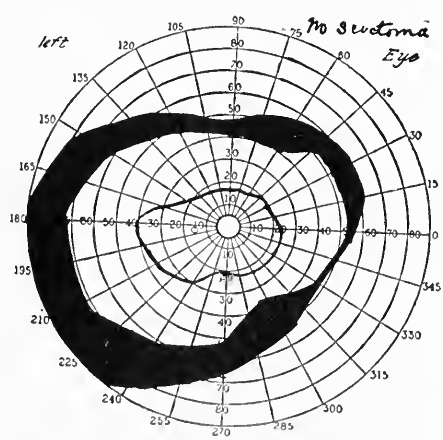


Fig. 2. Krauss's Unilateral Retrobulbar Neuritis due to Ethmoiditis.

chronic toxic neuritis, such as is produced by the combination of tobacco and alcohol in excess. The condition is seen both in those who smoke and those who drink to excess. Those who do these things

moderately, or not at all, and young men are seldom attacked, the patient being usually past 40 years. Twenty cases studied gave evidence of increased blood pressure, accentuation of the second sound of the heart, tortuosity of the superficial arteries, etc. He considers that there is a more or less pronounced alteration in the walls of those vessels which spring from the vaginal arteries from which are derived the capillary network of the nerve trunk. Cases with marked difference in the visual conditions of the two eyes show that the cause cannot be a purely toxic one. The atrophy of the optic nerve frequently found is due to arteriosclerotic changes. Hereditary optic nerve atrophy may be regarded as being dependent upon an early or congenital angiosclerosis similar to pigmentary degeneration of the retina. Kruger has also been able to detect ophthalmoscopic changes in the macular arteries and veins similar to those found in arteriosclerosis, hazy outlines of the arterial walls without circumscribed narrowings; irregular outlines with more or less contraction of the lumen; faint haze of the papilla or at the crossings of underlying veins, occasional breaking of the lumen of the vein by the underlying artery. There is also blanching of the outer half of the papilla. He is inclined to believe that the primary changes in retrobulbar neuritis are due to disease of the macular arteries causing disease of the macular fibres of the nerve showing secondarily in the retrobulbar portion of the optic nerve.

Kennedy's syndrome. In the presence of symptoms of brain tumor and the following symptom complex: true retrobulbar neuritis with a central scotoma, primary optic atrophy with concomitant papilledema in the opposite eye, Kennedy (*Oph. Year-Book,* p. 276, 1912) believes a diagnosis of tumor in the lower part of the frontal lobe on the same side as the retrobulbar neuritis and primary optic neuritis have occurred is justified. Out of six cases the accuracy of the diagnosis was proven by operation in five. In the other case a decompression operation was done.

Muschinski has given the history of a case of unilateral retrobulbar neuritis in a woman who two months before had had influenza. A thorough examination revealed no etiological factor. She was suffering from homolateral headache and pain in the superior maxilla. Ten days later external oculomotor palsy occurred, with slight exophthalmos. There was hyperalgesia of the trigeminus and a slight lesion of the facial and the acoustic nerves. The author considers the condition to have been one of intracranial neuritis in front of the chiasm probably due to a periostitis of the base of the skull.

Augstein (*Klin. Monatsbl. f. Augenheilk.,* Feb., 1913) gives the

history of a case of *acute bilateral retrobulbar neuritis* in an otherwise healthy man, aged 38, who had some years before otitis media and a nasal affection on the left side, and became blind within a few days with very severe headache on the left side but without any ophthalmoscopic changes. Opening of the ethmoidal and sphenoidal sinuses revealed normal conditions. Before the amaurosis was complete the visual field of the left eye was preserved in the upper nasal quadrant, and after this was abolished the sight of the left eye failed rapidly, with general contraction of the visual field and central relative scotomas, but in such a manner that perception in the temporal half was more diminished. Although a Wassermann test proved to be negative, the patient received energetic anti-syphilitic treatment with mercurial ointment, iodid of potassium, one injection of calomel oil and two injections of arsenobenzol, but without the least result after twenty-five days. Then all medication was discontinued and the patient removed from the clinic to his residence. On the 33d day perception of light returned and vision gradually became restored. Three months later it was R. 5/4, L. 2/15. With the improvement the visual fields showed the typical character of a retrobulbar neuritis with central scotomas for color, which gradually disappeared.

Augstein considers the case to be one of idiopathic retrobulbar neuritis due to autointoxication, which healed spontaneously, and excludes a syphilitic process, which would have responded to such energetic treatment much earlier. The severe headache and the lack of pain in extreme movements of the eyes indicated an intracranial localization of the inflammatory processes. Hence, no changes of the discs, excepting a very slight pallor of the temporal half of the left disc, were noticed at the last examination two years later. With regard to treatment the author says that acute retrobulbar neuritis takes a typical course, which also is characteristic for toxic influences, and is not likely to be altered by medication.

Lee M. Francis (*Journ., A. M. A.*, July 4, 1914) reports two cases of acute retrobulbar neuritis which were associated with a well-marked *acetonuria*. A thorough physical examination by competent observers revealed no definite findings except the presence of a pronounced reaction for acetone in the urine. Both patients were young, one a girl of 8½ and the other a man of 31. The girl had been an exceptionally healthy child, while the man gave a history of a previous attack of colitis coincident with marked acetonuria. Both lived under ideal hygienic conditions, being members of families in more than comfortable circumstances. In both cases, hysteria, disease of the nose and accessory air-passages, alcohol, tobacco and drugs could be eliminated

with certainty, nor were there any grounds on which the likelihood of chemical or ptomain poisoning might be entertained.

According to von Noorden, "the primary acetone bodies are beta-oxybutyric acid and aceto-acid, from which acetone is probably derived as a secondary product . . . by far the most important sources of acetone are the lower fatty acids." Whatever be the source or whether the virulence of the toxin in cases of faulty metabolism be acetone or some antecedent product or products, clinicians recognize that the excretion of acetone is a fair index of a toxemia. While acetonuria is not at all infrequent in children, and to a less extent in adults with gastro-intestinal disturbances, and invariably accompanies starvation, it may be fairly stated that acetone is not found in appreciable quantities in the urine of normal persons, and that its presence is an index of some toxemia of enough virulence to attack nervous tissue.

While it is quite obvious that acetone, beta oxybutyric acid or aceto-acetic acid exercise no decided selective action on the papillomacular bundle of the optic nerve, yet it appears reasonable according to Masters, that in certain cases it may produce a retrobulbar neuritis, and that these factors should be taken into consideration in the search for possible etiologic factors in cases of retrobulbar neuritis of otherwise obscure origin.

The relations between *multiple neuritis* (q. v.) and *retrobulbar neuritis* are well recognized.

Shumway (*Oph. Record*, Aug., 1915) also draws attention to the frequency of acute axial neuritis as an early symptom of disseminated sclerosis. This symptom is thoroughly recognized by ophthalmologists, but it is a question whether it is fully appreciated by physicians. He records a case which presented signs and symptoms of venereal disease, but after seven years' observation, insular sclerosis was regarded as the cause of the initial acute axial neuritis. He concludes that in isolated occurrence of acute axial neuritis a probable diagnosis of multiple sclerosis should only be made if toxic, hereditary, acute or chronic infective processes attacking the optic nerve can be excluded.

Tarle (*Klin. Monatsbl. f. Augenheilk.*, May, 1915) undertook to investigate the subject for the main purpose of determining how far it can be shown that at the time of onset of acute retrobulbar neuritis there are other neurological evidences of concurrent disease of the central nervous system, especially multiple sclerosis.

He excludes cases obviously due to local disease of the orbit, etc., and those due to toxic causes. This leaves 29 cases of acute retrobulbar neuritis. Nearly two-thirds of them were females. More than two-

thirds were between 15 and 30 years of age. The average age of onset was 27 years. As a rule, no cause was assigned, but some of the patients blamed cold, over-exertion, etc. The duration of the profound loss of vision varied from a few days to four weeks. Usually there was ultimate recovery of perfect vision, but there might be reduction of central vision, color scotoma, paracentral scotoma, or various combinations of these. The affection was bilateral in four cases, and possibly in two others.

In 11 of the cases there were nervous symptoms which, along with the eye symptoms, made a diagnosis of multiple sclerosis certain. In a number of others the diagnosis was probable.

His investigations therefore confirm the view that acute retrobulbar neuritis is an early and important sign of multiple sclerosis, and that in from one-third to one-half of the cases there is already at the time of the onset of the neuritis other evidence pointing to the existence of multiple sclerosis.

Seven instances of *retrobulbar neuritis localized in the chiasm* are furnished by H. Ronne (*Klin. Monatsbl. f. Augenheilk.*, 55, p. 68, 1916). The origin of the disease, the subjective symptoms, and the course are essentially identical with the severe forms of retrobulbar neuritis. The visual field is characterized most frequently by simultaneous hemianopic (often temporal hemianopic) defects and central scotomas. The defects often show a peculiar migratory type, which is not found in any other form of the disease. The affection frequently accompanies myelitis and multiple sclerosis, and is a retrobulbar neuritis, without regard to any form of optic neuritis or choked disc that may accompany it. The edema of the disc is secondary, and localized in the stem of the optic nerve and especially in the chiasm, and influences the visual field and the course of the disease. Corresponding retrobulbar neuritis with predominant localization in the chiasm is also found without concomitant spinal affections.

The *treatment of the various forms of retrobulbar neuritis* has already been considered. To this may be added the experience of Vazquez (*Oph. Year-Book*, p. 286, 1912), who successfully treated two cases of retrobulbar neuritis by lumbar puncture. In one case in which vision had been completely lost for six days normal vision was finally obtained after a second puncture. In a case of tabetic optic atrophy, in which in the only useful eye the field was greatly contracted, Goebel succeeded by massage of the optic nerve, in restoring the field to normal and restoring the perception of red. A bell, shaped like an eye cup, furnished with a rubber ball was placed over the lids and globe, the whole mass being sucked in and out synchronously with

the pulse rate. Garipuy holds that unlike atoxyl, arsacetin and perhaps hectin, salvarsan will not injure an inflamed optic nerve. Cases of neuritis discovered after the administration of salvarsan (*arsphenamin*), if not there previously, can be attributed to the original disease. He records two cases in support of his conclusion.

Retrobulbar tumors. Inasmuch as the orbit contains almost every variety of human tissues, numerous neoplasms originate in that cavity and are described under appropriate headings. See, e. g., **Orbit, Tumors of the,** p. 9187, Vol. X; **Exophthalmos,** p. 4850, Vol. VII; **Krönlein's operation,** p. 6871, Vol. IX; and **Orbit, Operations of the,** p. 9147, Vol. XII of this *Encyclopedia.*

Retrochoroidal hemorrhage. EXPULSIVE HEMORRHAGE. Bleeding behind the choroid, as, e. g., after cataract extraction. See p. 2130, Vol. III; and **Cataract, Senile,** p. 1728, Vol. III of this *Encyclopedia.*

Retrography. Same as mirror-writing. See p. 7843, Vol. X of this *Encyclopedia.*

Retro-iridian. Behind the iris.

Retro-ocular. Situated or occurring behind the eye; retrobulbar.

Retrotarsal. Behind the tarsus of the eye.

Retrotarsal folds. See **Fold of transmission.**

Retroversion of the iris. Partial or complete retroversion of the iris may follow a perforating or other wound of the eye which ruptures the suspensory ligament, dislocates the lens and produces a prolapse of the vitreous into the anterior chamber. Then the retroverted iris lies back against the ciliary body. See, also, **Injuries of the eye,** under *Injuries of the iris.*

Reuling, George. A distinguished ophthalmologist and oto-laryngologist of Baltimore, Md., widely known in particular as an operator on the eye, and the first American ophthalmologist to remove a cataractous lens within its capsule. Born in Darmstadt, Germany, Nov. 11, 1839, he studied medicine at the University of Giessen from 1860 till 1865, and, in 1865 and 1866, at Munich, Vienna, and Berlin. His degree was received at Giessen in May, 1866. From the day of his graduation until September of the same year he served as surgeon in the Prussian Army in the war against Austria. Late in 1866 he became assistant surgeon at the eye hospital, Wiesbaden. The following year he studied at Paris under de Wecker, Liebreich and Meyer.

In 1868 he removed to America, settling as ophthalmologist and oto-laryngologist in Baltimore. Here he was soon widely known as an operator on the eye. In 1869 he was appointed surgeon-in-charge of the Maryland Eye and Ear Infirmary. He was also at various times oculist and aurist to the Baltimore Home for the Aged and the German

Hospital. From 1871-73 he was professor of eye and ear surgery in the Washington University, and in 1893 was apointed to the chair of ophthalmology and otology in the Baltimore Medical College—a position which he held for many years. He was a member of numerous societies, both social and scientific, among them the American Academy of Arts and Sciences, the Heidelberg Ophthalmological Society, the American Laryngological, Otological and Rhinological Society.

George Reuling.

Dr. Reuling was a man of medium height, fair complexioned and with dark-blue, slightly grayish, eyes. He wore, as a rule, a small mustache. He was calm, placid and deliberate in his manner, and was seldom known to be excited. He was very fond of art and music, and kept at his residence, 103 West Monument Street, a splendid collection of antique paintings. He was a member of the German Lutheran Church.

The Doctor married, September 21, 1871, Miss Eliza Knelp, daughter of Captain F. Knelp, of Darmstadt, Germany. They had two children, Robert C. Reuling, a well known physician of Baltimore, and Marie R., now the wife of Richard H. Pleasants.

Reuling died in his 66th year at the Maryland General Hospital in

Baltimore, November 26, 1915, from a complication of diseases. He had been sick for a long time, and his death was not unexpected.—(T. H. S.)

Reuss, Adolf. A German-American physician, who devoted considerable attention to ophthalmology. Born at Frankfort a. m. in 1804, he received his medical degree at Göttingen in 1825, presenting as dissertation "Diss. Anatomico-Physiologica de Systemate Lentis Crystallinae Humanæ." He practised for a time at Frankfort, but in 1834, removed to Belleville, Illinois. He died on his farm at Shiloh, Ohio, May 7, 1878.—(T. H. S.)

Reuss' ophthalmodiaphanoscope. See p. 3947, Vol. V of this *Encyclopedia.*

Révélateur. (F.) Developer.

Reverberator. That which reflects vibratory motion, especially light.

Reverdins's operation. For blepharoplasty; see p. 1056, Vol. II of this *Encyclopedia.*

Reversal of color-fields. The normal areæ of the color fields occasionally show a reversal, inversion or transposition, the smallest becoming the largest, etc. This condition is found especially in hysteria and in brain tumors.

Reversal of the image. A phrase applied in photography to the phenomenon resulting in the parts of the image which should appear light, becoming dark, and vice versa.

Reversed Argyll Robertson pupil. Preservation of the light reflex and loss of convergence accommodation reflex, is a comparatively rare phenomenon, but it has been observed in tabes. It is difficult to explain, but in all probability it is of nuclear origin, the reflex arc for light having escaped. Great care should be observed in establishing its presence by making the examination under the most favorable conditions in a darkened room. See **Pupil in health and disease.**

Reverse vision. Reverse seeing. In addition to the section on mirror-writing, as well as under the rubrics on p. 6561, Vol. IX of this *Encyclopedia*, M. Bargy (*La Clinique Ophtalm.*, Oct., 1916) reports two curious cases of reversed vision. A young lady complained to him that one evening when she had read and written more than usual she had an atrocious headache; the letters danced before her eyes and at the same time each letter appeared reversed. After several moments of rest the phenomenon disappeared, only to return twice at different times the same evening.

During the same week on three different occasions the symptoms returned. She did not dare to tell her parents, but she went to an op-

tician to find out whether she needed any glasses. All the glasses she tried blurred her vision. She looked very well, but seemed to be emotional; she called herself very "neurasthenized", and her great trouble was that she had been married for five years without having given birth to a child.

Bargy quotes from the *"Memoirs"* of George Sand who in a Venetian gondola saw "the narrow canals which serve as streets traversed by small bridges of one arch for passage by foot; my vision was so used up by night watches that I saw all objects reversed and especially these rows of bridges which presented themselves before me as arches turned over on their bases." The author does not try to explain the pathogenesis of this symptom; all sorts of theories are possible, except a congenital disposition of the optic tracts. There is one common cause: intellectual and visual overwork. Seeing reverse then appears as a fleeting epiphenomenon of a special psychical state.

Reversing layer. A hypothetical absorptive stratum of the solar atmosphere.

Reversing prism. A small obtuse-angled isoseles prism of flint glass.

Revolving diaphragm. A round plate of metal, perforated with holes of different diameter, which can be brought into the axial line of the lens.

Revolving prism. See p. 4692, Vol. VI of this *Encyclopedia.*

Reybard, Jean François. A well-known French surgeon who occupied himself considerably with diseases of the lachrymal drainage apparatus. Born in 1790 at Croysiat (Jura) he received his medical degree at Paris in 1816. He practised first at Annonay, then at Lyons. A very kindly and charitable man, he not only treated and operated on the poor *gratis*, but he even gave them board, lodging and clothing without money and without price. He invented a worthless instrument with which he perforated the lachrymal bone in cases of dacryocystitis. His writings of a special ophthalmologic character are: "Nouv. Procédé pour Guerir la Fistule Lacrimale." (*Arch. Génér.*, 1852) and "Etiologie des Fistules Lacrymales" (*Gaz. Heb.*, 1862). He died in Paris, in September, 1863, of an infected wound of the finger, received during the performance of an operation.—(T. H. S.)

Reymond, Carlo. A famous Italian ophthalmologist. Born at Albertville, Savoie, Oct. 29 (Nov. 26) 1833, he received the degree of M. D. at Turin in 1857. In 1876 he was appointed professor of ophthalmology in his alma mater, a position which he held until his death, July 9, 1911.

The following estimate of Reymond is from the pen of Antonelli (in the *"Ophthalmoscope,"* for Sep., 1911, pp. 673-674): "His sub-

stantial culture in all the branches of ophthalmology enabled him to inspire and to guide, according to the different aptitudes of his students, the works of what may be described, so to say, as a nursery garden of young ophthalmic surgeons, which he had gathered around him at Turin. His authority, his great influence in University circles, and his determination combined to render him all-powerful in the selection of his favorite pupils, so that, in fact, all the chairs of ophthalmology in the Italian Universities are occupied by oculists who were educated at Turin. A clever operator, Reymond was among the first in Italy to apply antiseptic principles to eye surgery, particularly in the operation for cataract. Constantly traveling, rarely missing any of the foreign congresses, he had acquired, with the help of Donders, a taste for studies in refraction, a subject which he popularized in Italy. His publications in this domain of ophthalmology were both numerous and important, a remark which also applies to other branches of our specialty, notably in the chapters dealing with toxic amblyopias, hemeralopia and xerosis, and the deeper affections of the eye.''—(T. H. S.)

Reynolds, Dudley Sharpe. A prominent ophthalmologist of Louisville, Ky. Born near Bowling Green, Warren Co., Ky., Aug. 31, 1842, son of Rev. Thomas, and Mary Nichols, Reynolds, he received the degree of A. M. at Ogden College, Bowling Green, and, in 1868, the medical degree at the University of Louisville. From 1869-71 he was surgeon-in-chief to the Western Dispensary—a position which he resigned to begin the study of ophthalmology and otology. After a considerable period at the University of Pennsylvania, the Wills Eye Hospital, Philadelphia, and the New York Eye and Ear Infirmary, he proceeded to Europe where he studied at the Royal London Ophthalmic Hospital (Moorfields), the London Throat Hospital, and, in Utrecht, under Donders and Snellen, in Paris under deWecker, Sichel, Ed. Meyer, and Galezowski; in Vienna under Stellwag, Fuchs, Gruber and Politzer; in Berlin, under Schweigger, Hirschberg, and Von Bergmann.

Returning to America, he was soon widely known as an oto-ophthalmologist. One of the organizers of the Hospital College of Medicine (the Medical Department of the Central University of Ky.), he was professor of ophthalmology and oto-laryngology at this institution from its very inception in 1874. He was also professor of general pathology and hygiene from 1882 to '92. In 1892, on the establishment of a chair of medical jurisprudence at the college in question, Dr. Reynolds was made the first incumbent, retaining the position until 1901, when he retired from teaching altogether.

Dr. Reynolds was one of the organizers of the Association of American Medical Colleges, and was Chairman of the Judicial Council of that body for a number of years. He was later the chairman of the Judicial Council of the Association of American Medical Colleges. In 1880 he was elected Chairman of the Section of Ophthalmology, Otology, and Laryngology of the American Medical Association. He was once foreign delegate of the A. M. A., and in 1881, was made an honorary member of the British Medical Association. In 1887 he was President of the Mississippi Valley Medical Association.

Dr. Reynolds was thrice married: first, on May 7, 1865, to Mary F.

Dudley Sharpe Reynolds.

Keagam; again, on July 13, 1881, to Matilda L. Bruce; and, on June 5, 1907, to Lillie B. Baldwin.

He died at his country home, "West Meath Farm," near Louisville, Ky., Feb. 4, 1915.

Dr. Reynolds was a large, stout man, smooth-faced, of fair complexion, and with bright blue eyes and brown hair. He was very deliberate and thoughtful as an operator, but, at his home and in social life, he was cheerful and even gay. He was fond of fishing and country life in general, and, for the last seven years of his life, he lived in the country near Louisville, while continuing to practice in that city. He was a very broad-minded, and public-spirited man, a Democrat in politics, but interested in all phases of public affairs, regardless of party affiliations. One who knew him, writes: "When the property of the Public Library of Kentucky, as it was then known, was about to

be sold by the sheriff to satisfy a judgment of the Louisville Chancery Court, he secured the co-operation of about fifty of the best citizens of Louisville, and re-organized the Polytechnic Society of Kentucky, which, by act of the Legislature, had been authorized to take charge of the Public Library property. At a meeting in January, 1879, Dr. Reynolds and four other gentlemen, having gone into bank and raised the money, paying off the judgment of $9,000.00, took charge of the property in the name of the Polytechnic Society of Kentucky. This society elected Dr. Reynolds and his four collegues, members of the Board of Directors for five years in recognition of their services in preventing the public sale. As Chairman of the Library Committee, he purchased about 10,000 volumes of the books now in the Library.''

Dr. Reynolds will long be remembered, not only in ophthalmology, but also in general medicine, and in medical jurisprudence. He will also not only be remembered in the college in which he served so long and faithfully, but also in the city in which he practised, and throughout his native state.—(T. H. S.)

Reynolds, Edward. A famous American surgeon, one of the founders of the Tremont Medical School and of the Massachusetts Charitable Eye and Ear Infirmary. Born at Boston, Mass., in February, 1793, he received the degree of A. B. at Harvard College in 1811, and, for a time, was engaged in the study of medicine with Dr. John Collins Warren. Then for three full years he studied at Paris and London, in the latter city coming much under the influence of Sir William Lawrence, who turned his attention strongly toward diseases of the eye.

Returning to Boston, Dr. Reynolds found his aged father blind from double-sided cataract. With a boldness rare enough among the operators even of the present day, he couched both lenses at a single sitting, and both the couchments were brilliantly successful. The cataract operation had not previously been performed at all in Boston, and the consequence was that Reynolds was a made man.

In 1824 Reynolds, together with John Jeffries, established a dispensary which developed into the well known Massachusetts Charitable Eye and Ear Infirmary. Jeffries, for a time, was senior surgeon, but, upon his resignation, the vacancy was filled by Reynolds.

Reynolds was one of the founders of the Tremont Medical School, in which he was professor of surgery for some years. He also, for a time, taught anatomy and surgery at the Harvard Medical School. In 1864, at the founding of the American Ophthalmological Society, he was made an honorary member.

He was a large, tall man, bony and very muscular. He was kind,

unselfish, witty and a boon companion. He suffered much from deafness, however, in his later days.

Dr. Reynolds married, first, Adeline Ellen, daughter of Wm. Pratt, of Liverpool, England, and, second, Margaret Wendell Phillips, of Boston. At the second union were born one son and five daughters.

Dr. Reynolds died at Boston in 1881, being eighty-nine years of age.—(T. H. S.)

Rhabdomyoma. A myoma composed of striated muscular fibers; called also *myoma striocellulare*. See p. 9186, Vol. XII of this *Encyclopedia*.

Rhagades. See **Eyelids, Fissures of the.** See p. 5006, Vol. VII of this *Encyclopedia*.

Rhanter. (L.) Inner canthus.

Rhaphania maisitica. Pellagra; so called because supposed to be due to the use of maize as food.

Rhaphiancistrum. A hooked needle formerly used in the formation of an artificial pupil.

Rhazes. See **Ar-Razi.**

Rhegma oculi. Rupture of the eyeball.

Rheostat. An apparatus for regulating the intensity of an electrical current by interposing an adjustable length of some substance that is relatively a poor conductor. See p. 4199, Vol. VI of this *Encyclopedia*.

Rheumatic iridochoroiditis. A plastic form of iridochoroiditis with a marked tendency to relapses, due to a "rheumatic diathesis." It is always chronic and obstinate in resisting treatment, and tends to the destruction of the ocular functions.

Rheumatism, Ocular relations of. The term rheumatism is a remnant of an ancient nomenclature and is loosely employed to designate a great number of morbid conditions many of them related in no way to one another. Used originally by the humoral pathologists to indicate the circulation of disordered "humors," it was later applied to a variety of fleeting pains in many parts of the body, i. e., to a symptom. As such pains were commonly produced by exposure to cold and dampness, many disorders that followed such exposure were called rheumatic, so that the term was used in an etiologic sense. As the joints were commonly affected in these disorders, the term rheumatism was then rather loosely employed to designate joint affections in general. Finally, a "rheumatic diathesis" was constructed in which there was said to be a special predisposition to articular involvement ("arthritism" of the French).

Designated as "rheumatism" but not at all belonging to it are, first, acute articular rheumatism or rheumatic fever, an infectious disease; second, a variety of articular affections, grouped under the most

unfortunate name "pseudo-rheumatism," that are of parasitic origin (staphylococcus, gonococcus, pneumococcus, diphtheritic, tuberculous, influenza bacteria); third, the acute articular lesions of gout. Muscular rheumatism is generally a myalgia, possibly a neuritis of the small muscular nerves.

"In fact the words rheumatism and rheumatic are often so loosely employed that they have almost forfeited all claims to be regarded as scientific terms." This from no less authority than A. E. Garrod. Nevertheless it appears necessary to discuss very briefly the treatment of that vague array of symptoms called rheumatic involving almost every organ of the body, including portions of the ocular apparatus, and commonly attributed to some derangement of the uric acid metabolism or to some altogether obscure underlying cause that affects in most cases the joints and tendon sheaths, or that develops consecutively to articular lesions.

Prophylaxis is of the greatest importance and must concern itself chiefly with the general hygiene and the diet. The domicile should be dry, well ventilated and light, for moisture and lack of sunlight undoubtedly predispose to the development of the disease. Depressing psychic influences should be counteracted. The patients should be protected against exposure to wet weather or sudden temperature changes. The clothing is of the greatest importance; linen or cotton should never be worn close to the skin; for these textures favor rapid radiation of heat, become wet and cling to the body when the patient perspires and hence obliterate the layer of immovable air that should intervene between the skin and the first garment. Wool, flannel or silk are, therefore, the best.

The diet should be nutritious, without overloading the stomach. Underfeeding is especially to be avoided. The patients should drink plenty of water preferably some alkaline water with slightly laxative properties.

In cases that are "gouty," i. e., in which a perversion of the uric acid metabolism can be postulated or definitely determined by careful metabolic studies the following dietetic considerations should govern the feeding of the patients: There is much disagreement and misunderstanding in regard to the use of meat, some extremists interdicting the use of meat altogether; others making artificial distinction between dark and red meats; others again insisting upon a diet consisting exclusively of red meat, "Salisbury diet." The use of moderate amounts of meat is not only permissible but necessary; some care, only, should be exercised in the selection of the kind of meat and its mode of preparation.

The chief source of circulating uric acid and its dangerous congeners, the purin bases, being the nucleins, every effort should be made to reduce the ingestion of articles of food containing the latter or their derivatives. Hence all meats containing many cell nuclei, i. e., all internal organs, as liver, sweet-breads, kidney, brain, thymus, should be forbidden. All meat extracts, broths, sauces and gravies containing the so-called "extractives" of meat are equally bad, because they are solutions of the above mentioned purin bases, and the latter are rapidly converted into uric acid in their passage through the body; besides they are themselves possibly a prolific source of many of the troubles commonly attributed to the action of uric acid. To exclude the flesh of fowls because birds produce more uric acid than animals is based on wrong conclusions; and it has also been shown that there is no difference between dark and white meats, with this exception, that raw or underdone meats still contain some of the extractives, whereas thoroughly boiled meats do not; for this reason, too, boiled meat is safer than fried or roast meat. The most important point to remember is that the albumen of the meat proper exercises no direct effect on the uric acid economy but that the nucleins alone contribute to an accumulation of uric acid and its congeners. It is wrong to place these patients for indefinite periods of time on a vegetarian diet, for undernutrition is almost certain to result unless the metabolism is carefully studied and the diet arranged accordingly.

Too much meat on the other hand is also dangerous, for it produces acidulation of the blood stream in several ways and also leads to an increased digestion-leucocytosis that causes some uric acid increase by the disintegration of numerous leucocytic nuclei. Eggs may be permitted in reasonable limits; the same applies to milk. Cheese is poor in basic salts as they remain dissolved in the whey; hence it leads indirectly to blood acidulation owing to its failure to neutralize circulating acids derived from albumen oxidation. Empirically, in fact, cheese has been found to be especially detrimental and it is, therefore, best forbidden. Carbohydrates and fats can be taken practically ad libitum excepting in those, not infrequent, instances in which diabetes and obesity complicate the uric acid diathesis. Most vegetables are allowed, with the exception of young, germinating plants that contain abundant nuclein.

The best beverage is pure water, but not in excessive quantities, as it has been shown clearly that forced water drinking does not materially increase the uric acid or purin base excretion, while impairing gastric digestion and seriously overtaxing the cardio-vascular apparatus. Mineral waters, especially of the alkaline variety, are useful;

waters containing abundant lime are particularly valuable, as calcium possesses powers to a marked degree of preventing the precipitation of uratic deposits. Lithium waters, aside from the fact that most of them contain no lithium or at best only minimal quantities, and that lithium is of no greater use, popular prejudice to the contrary notwithstanding, than any other alkali, are not to be recommended in particular. In fact, the great benefits no doubt occasionally derived from a visit to some watering place are, as a rule, attributable rather more to the change from the ordinary routine, to the regular life, to the rest, the fresh air and the exercise obtained, possibly also to the drinking of much water, than to any healing powers of the salts that these different waters may contain.

Milk and buttermilk are both excellent beverages. Tea and coffee should be taken very moderately, also cocoa, and the less of alcoholic liquors a sufferer from uratic disorders ingests the better.

As to the medicaments little need be said. Abundant alkali in some form, preferably as sodium or calcium carbonate, careful regulation of the function of the digestive apparatus, i. e., free evacuation of the bowel contents by mild laxatives, here and there an hepatic stimulant or an intestinal antiseptic as fully discussed elsewhere.

Most uric acid instances are best treated as cases of hepatic insufficiency, for the derangement of the nuclein metabolism will be found to be chiefly connected with derangement of certain liver function.—(A. C. C.)

Since the foregoing was written the ophthalmologist has been duly instructed in the importance of *focal infections* and in the removal of teeth, tonsils and other organs suspected of being a source of streptococcic and other morbific organisms likely to produce the rheumatic state. See, on this score, **Iritis.** For further discussion of this important subject see p. 5350, Vol. VII of this *Encyclopedia,* as well as **Toxic amblyopia.**

Rheumatophthalmia. Rheumatic ophthalmia.

Rhexis iridis. Tears through the entire width of the iris. See **Injuries of the eye.**

Rhexis, Sphincter. See *laceration of the iris,* towards the end of the heading **Injuries of the eye**; also, **Rhexis iridis.**

Rhigolene. A light, inflammable petroleum distillate composed of butane and certain hydrocarbons. It evaporates rapidly, producing a lowering of the temperature (to —15°C.) of the surface from which it evaporates. It is used as a local freezing anesthetic for minor surgical operations—on the facial and lid skin, for example. See **Anesthesia, Local,** p. 455, Vol. I of this *Encyclopedia.*

Rhinalgin. An antiseptic and analgesic preparation of alumnol, oil of valerian, menthol, and cocoa-butter; used in affections of the nose and eyes.

Rhincestrus nasalis. See p. 8262, Vol. XI of this *Encyclopedia.*

Rhinoculin. A proprietary anesthetic ointment containing *anesthesin* (q. v.) for use in hay-fever. The irritation of the eyes is said to be relieved by applying it to the inner canthus by means of a fine hair brush.

Rhinodacryolith. A lachrymal calculus in the nasal duct.

Rhinclogy in ophthalmology. See **Cavities, Neighboring,** p. 1810, Vol. III of this *Encyclopedia.*

Rhincrraphy. An operation for epicanthus. See p. 4478, Vol. VI of this *Encyclopedia.*

Rhinoscope. An instrument used in ocularly examining the interior of the nose.

Rhinosporidium kinealyi. A sporozoan parasite found in tumors of the lachrymal canals, nasopharynx, nasal cavities and septum of East Indians. It is occasionally found in conjunctival growths, as demonstrated by R. H. Elliot and A. C. Ingram (*Ophthalmoscope*, Aug., 1912).

H. Kirkpatrick (*Ophthalmoscope*, p. 477, Sept., 1916) reports a case of *rhinosporidium of the lachrymal sac.* A male, 32 years of age, was admitted to the hospital, Feb. 4, 1915. He complained of swelling at the inner side of his left orbit, which occasionally gave him some slight pain. The swelling had been noticed for a year. At first it was intermittent and caused no lachrymation. Two months previous to admission, the symptoms had become much more evident, and when first seen, was somewhat larger than a kidney bean. The swelling disappeared on pressure and a quantity of pus passed into the nose. The skin covering the swollen area was slightly inflamed. The sac was excised in three pieces, February 6. It was filled with thick, creamy pus; the walls were soft and lined with granulation tissue and small polypoid growths. The sac was adherent to the adjacent inflamed orbital tissue. The wound healed and the patient was discharged on the sixth day.

One month later there was bleeding from the left nostril and he complained of slight pain at the site of the wound. On April 9, 1915, a small, hard and slightly tender lump was found beneath the operation scar. The next day a mass of soft, fibrous, inflammatory tissue, and creamy pus were removed. The lachrymal groove, which was partly carious, and the wound, were curetted, the cavity irrigated with a soluiton of quinin (10 gr. to the ounce) and the wound closed

with sutures. The patient was discharged on April 17. Ten months after the last operation there was no sign of recurrence. Histological examination of the removed tissue revealed granulation tissue, numerous small cysts, pansporoblasts and sporemorulæ.

Rhinostomy. A name for Toti's and similar operations. See **Cavities, Neighboring.**

Rhinoestrus purpureus. Russian sheep bot-fly, that occasionally attacks the human ocular apparatus. See **Oestrus ovis.**

Rhoads, George. A well-known homeopathic ophthalmologist and otolaryngologist. Born at Richmond, Vt., Oct. 7, 1859, the son of Cornelius Peltiah and Marietta Russell Rhoads, he received his liberal training at the Goddard Seminary and at the University of Vermont. He then studied medicine at the Hahnemann Medical College, Philadelphia. He practised for a time at Fitchburg, Mass., then at Winchendon, and removed in 1894 to Springfield, where he remained until his death. He was a man of great integrity, and had many friends. He married Sep. 22, 1896, Miss Harriet Barney, of South Hadley Falls, who, with a son and a daughter, survive him. After years of ill-health he died, Mar. 29, 1912, of aneurism of the aorta.—(T. H. S.)

Rhodalline. See **Thiosinamine.**

Rhododendron cinnabarinum. VERMILION-FLOWERED RHODODENDRON. An East Indian poisonous plant said to kill goats that eat it, and to produce, when used as fuel, swelling of the face and inflammation of the eyes.

Rhodogenesis. The restoration of the purple tint to rhodopsin after it has become bleached by the action of light. Coccius (*System of Diseases of the Eye*, I, p. 637) observed a marked pallor of the retina in rabbits kept for a long time in the bright sunshine and then half an hour in darkness. Restoration to normal took from seven to thirty minutes. Living retinæ that have in this or other ways been bleached do not show visual yellow but do exhibit lilac, rose and purple. In any case the visual purple must be formed anew—a true neogenesis. See **Photochemistry,** p. 9697, Vol. XIII of this *Encyclopedia;* and especially **Bleaching of the visual purple,** p. 1015, Vol. II.

Rhodophane. A red pigment, or chromophane, from the retinal cones of birds and fishes.

Rhodophylaxis. The supposed property of the retinal epithelium of protecting and increasing the power of the retinal purple to regain its color after bleaching.

Rhodopsin. See **Bleaching of the visual purple,** p. 1014, Vol. II; as well as **Histology of the eye,** in this *Encyclopedia.*

Rhodostagma. An old term for rose-water.

Rhomb, Fresnel's. In crystallography, a rhomb is a solid bounded by six equal and similar planes. Fresnel's rhomb is so constructed that a beam of plane polarized light passed through it emerges circularly polized, after being twice totally reflected within the rhomb. See **Fresnel's rhomb.**

Rhomboid. (a) A quadrilateral figure whose opposite sides and angles are equal, but which is neither equilateral nor equiangular; a nonequilateral oblique parallelogram; a rhomboides. (b) Having a form approaching that of a rhomb; rhomboidal.

Rhombohedron. A solid bounded by six rhombic planes.

Rhubarb. *Rheum raponticum.* In ancient Greco-Roman times, rhubarb leaves, wet with the wine of raisins, was a favorite remedy for epiphora.—(T. H. S.)

Rhumkorff coil. See p. 4195, Vol. VI of this *Encyclopedia.*

Rhus diversiloba. See **Rhus toxicodendron.**

Rhus toxicodendron. RHUS DIVERSILOBA. POISON-IVY. POISON-OAK. RHUS VENENATA. Poisonous species capable of setting up inflammation of the eyes.

The vulgar terms "poison-oak," "poison-sumac" and "poison-ivy" are often confounded, and used indifferently for various plants whose emanations into or contact with the external eye may produce extreme irritation; and this fact should be kept well in mind when reading contributions to the subject. Consult p. 3836, Vol. V, and p. 10300, Vol. XIII of this *Encyclopedia.* Dorland's *Dictionary* (1917) thus describes *rhus toxicodendron; poison-oak; American poison-ivy.* A shrub found in woods and fields and along fences from Canada to Georgia. All parts of the plant, especially the leaves and root, contain a poisonous, caustic, milky juice, which on contact with the human skin produces in most persons redness, itching, swelling, and vesication. Some are so susceptible to the poison that even an exhalation from the leaves will produce an erysipelatoid affection of the face or hands. Several cases of poisoning, accompanied by drowsiness, stupor, vomiting, convulsions, and vesicular eruptions, have been recorded from the internal use of the fruit and root.

A leading article in the *Journ. Am. Med. Assocn.* (p. 1375, Nov. 4, 1916) refers to the subject at length and as follows: The discussion of the etiology and mechanism of poisoning through the agency of the poison oak (*Rhus diversiloba* T. and G.) and its near relatives, poison ivy (*Rhus toxicodendron* L.), and Japanese poisonous sumac (*Rhus vernix* L.), in recent issues of *The Journal*, seems to indicate an especial interest in this subject. It becomes apparent that some

believers in the toxicity of these plants postulate the poison to be of a gaseous nature, so that it can easily be transmitted without contact with parts of the plant. Some assert the probability of a bacterial nature of the poison in order to explain the often subtle and otherwise apparently inexplicable spread of the signs of affection with rhus intoxication. Others maintain that contact is necessary and that the toxic agent is unquestionably a chemical substance of defined properties.

A series of experiments, recently reported by McNair (*Journ. Infect. Dis.*, p. 429, 1916) establishes a number of facts concerning the active principles of poison oak. McNair, to whom we already owe chemical studies previously referred to on the nature of oak poison, has tried some crucial experiments to determine or exclude certain of the possibilities of transmission of rhus poisoning still in doubt. These points were already known for poison ivy and poison sumac. The nonbacteriologic nature of the toxic substance, its nonvolatility, its resinous nature, its absence in the pollen and plant hairs, and its chemical properties were determined by the methods previously employed by other investigators in their studies of the poisonous constituents of the related plants. In fact, the results indicate that the toxic agents in the several plants are identical or very closely related.

The oft repeated assertion that poisoning may result from exposure to smoke from burning stems is experimentally verified. Smoke from the heated leaves causes dermatitis if blown on the wrist. If, however, the smoke is filtered through glass wool, it will no longer produce toxic effects, showing that smoke is only a mechanical carrier of the poison.

The part of the plant to be feared is the resinous sap. This sticky sap, exuding from all parts of an injured plant, comes into contact with hands or other exposed portions of the body, and may even be carried indirectly on clothing, tools, insects, smoke, etc., to the skin of persons far from the actual neighborhood of the plant, giving rise to those mysterious "recurrent" cases of oak poisoning. Sap thus carried loses its toxic properties by oxidation, the rate of loss being most rapid when the temperature is blood heat and the atmosphere humid. The irritant in the sticky resinous sap slowly diffuses through sudoriparous and sebaceous ducts, hair follicles, and through the skin itself where it is thin and delicate.

A suggestion has been advanced that possibly insects carry poison from plant to person. This McNair believes cannot, from present evidence, be denied; but it is doubtful whether severe cases of rhus dermatitis can be caused by the small amount of rhus poison that an insect might carry.

The principal lesions of dermatitis venenata from poison oak have been described by White (*Dermatitis Venenata,* 1887). McNair adds to the symptoms already recorded an accompanying leukocytosis (in severe cases blood counts frequently giving more than 12,000 leukocytes to the cubic millimeter), and constitutional disturbances, such as fever, coated tongue, loss of appetite, constipation, and a trace of albumin in the urine (he records one case in which an acute nephritis developed). As diagnosis is occasionally difficult, certain peculiarities may be noted, distinguishing it from eczema and herpes. Oak poisoning frequently begins between the fingers, and is markedly acute in character, with swelling and often large vesicles and blebs, the exudate from which is nontoxic. It occurs in sharply-defined patches, elongated streaks, and other irregular shapes corresponding with the original area of contact. It does not follow the nerve trunks. It seldom attacks the scalp or the inside of the hands. The areas of the skin to which the poison has been conveyed from the original site of contact are usually less affected. It may subside in from four to six days, depending on the amount of the irritant and the sensitiveness of the skin.

Violent inflammation of the *skin of the lids* is frequently caused by rhus poisoning, extending from the skin of the face (dermatitis venenata). It is the result of contact with the "poison ivy" (*Rhus venenata*) or with the "poison oak" (*Rhus toxicodendron*). The lids are swollen and puffy, of a deep-red color, and the subcutaneous tissue is edematous. In severe cases the eyes are completely closed. The symptoms begin with burning and itching, which often become intense. Patches of vesicles develop, sometimes confluent, exuding a yellowish fluid which on drying forms a thin soft crust. The disease is self limited and the acute symptoms usually subside in a few days. Dilute lead-water is a most soothing application.

Rhus venenata. See **Rhus toxicodendron.**

Rhus vernix. The Japanese variety of poison sumac; this specific name is also given to the common "poison sumac" of the United States and Canada.

Rhythmic exercise. GYMNASTIC EXERCISES. See p. 5671, Vol. VII, and p. 8009, Vol. X of this *Encyclopedia.*

Rhytidosis. (Obs.) Atrophy and wrinkling of the cornea, with, according to some authors, atrophy of the entire eyeball; one of the signs of approaching death.

Ribbon-shaped opacity. See **Band-shaped keratitis,** p. 877, Vol. II of this *Encyclopedia.*

Riberi, Alessandro. A celebrated Turinese ophthalmologist, inventor

of an excellent ectropion operation for the lower lid, a procedure which is, however, only occasionally called by his name. This is the well-known operation whereby a V-shaped incision is made in the skin of the lid and of the cheek below it, apex downward, the sides extending to the inner and the outer canthus of the eye respectively. (See **Blepharoplasty.**) The procedure in question has been attributed, quite wrongly, both to Thomas Wharton Jones and to Velpeau.

Riberi was born in 1794, settled at Turin, became professor of surgery and obstetrics at Turin University and president of the Medical Faculty, and died in 1861.

His chief ophthalmic writings are as follows: 1. Trattato di Blepharottalmo-Terapia Operativa. (Torino, 1837, 2d ed., 1839). 2. Su i Seni e su le Fistole delle Vie Lagrimali. 3. Della Ceratitide. (Torino, 1839.)—(T. H. S.)

Ribgrass. See **Plantago**, p. 10251, Vol. XIII of this *Encyclopedia.*

Rice. *Rice starch* is used as a desiccating powder in certain eye affections, notably in *herpes zoster ophthalmicus.*

About the only reference to ocular symptoms from sour or "spoiled" rice is that given by Lewin and Guillery (*Wirkungen von Giften auf das Auge,* I, 653) in which it is said that for 300 years travelers in the Moluccas have reported a transitory amblyopia from its ingestion.

J. M. Penichet (*Cronica Med. Quirurg.*, September, 1915) reports the case of a patient who felt as though a foreign body had entered his eye. The disturbance had diminished by the time he reached the oculist first consulted, who found only a traumatic conjunctivitis of uncertain origin. The treatment lasted five weeks, at the end of which time Penichet himself diagnosed a chronic conjunctivitis. At a second examination, however, the upper lid was everted more thoroughly than before, and at the deepest part of the cul-de-sac was seen a white point which was taken for a minute abscess. On incising it with a small bistoury, there escaped three-fourths of a grain of rice. The rest of the grain fell out three days later.

A "naturalist friend" stated that the grain of rice had swollen, that its envelopes had begun to break, and that the rootlets were unfolding themselves within the grain.

Richet's operation. For blepharoplasty; see p. 1090, Vol. II of this *Encyclopedia.*

Richter, August Gottlieb. One of the most famous of German surgeons and ophthalmologists. Born at Zoerbig, Saxony, April 13, 1742, the nephew of a well-known Göttingen professor of medicine, he re-

ceived his medical degree at Göttingen in 1760, his dissertation being "De Prisca Roma in Medicos suos haud Iniqua." After extensive travels in search of further scientific education, he returned to Göttingen, where, in 1766, he was made extraordinary professor of medicine, and, five years later, full professor. He was both an eloquent speaker and a dextrous and highly successful operator. Being of a

August Gottlieb Richter.

warm heart and frank disposition, he was almost worshipped by his students. He simplified and made more practical the surgical technique of his day, and for these facts alone he deserves the title he has always borne of the "Reformer of German Surgery." Among his numerous services, furthermore, should not be forgotten that of putting an effective brake upon the reckless operating of his day. In ophthalmology he rendered the special service of removing the cataract-extraction operation (Daviel, 1748) almost entirely from the hands of the itinerant quack and of placing it in those of the scientific surgeon.

According to Hirschberg he was also probably the first to call attention to the fact that frontal sinus inflammation may be the cause of ocular inflammation and even blindness.

He died July 23, 1812, after a very brief illness.

Of Richter's general writings, the following should be remembered even by ophthalmologists, so epoch-making are they: 1. *Chirurgische Bibliothek.* 2. *Abhandlung von den Brüchen.* (2 vols., 1777, '79. Still regarded as a very useful work.) 3. *Anfangsgründe der Wundarzneikunst.* (7 vols., 1782-1804.) 4. *Specielle Therapie.* (9 vols., and a supplement. vol., Berlin, 1813-'36.)

His ophthalmologic writings are as follows: 1. *Varias Cataractam Extrahendi Methodos Exponit et ad Orationem qua Munus Professoris Med. Extraord.* Clementissime sibi Demandatum die viii Oct. 1766 Aditurus est. . . . . Invitat D. Aug. Gottlieb Richter, Gott., 1766, 4to. 2. *Operationes Aliquot, quibus Cataractam Extrahit,* Gott., 1768, 4to. 3. *Observ. Chir. Fascic. Continens de Cataractae Extractione Observationes.* (Gott., 1770, 8vo.) 4. *D. August Gottlieb Richters d. Arzneigelahrtheit Ordentlichen Lehrers auf der Univ. zu Göttingen und d. Köngl. Gesellsch. der Wissensch. daselbst Mitglieds,* Abhandlung von der Ausziehung des Grauen Stars. (Göttingen, 1773.) 5. *Observ. de Fistula Lacrymale.* (*Comment. Soc. Reg. Scient. Göttingen,* I, 1778.)—(T. H. S.)

Richtungslinie des Sehens. (G.) Visual line of direction.

Richtungsstrahl. (G.) Ray of direction; axial ray.

Ricin. A poisonous albumin from the seed of the castor oil plant. It was with abrin and ricin (that readily produce in animals specific antitoxins) that Ehrlich experimented in working out his side-chain theory.

Ricinus communis. Castor-bean. Castor-oil plant. The seeds (castor-seeds) contain an acrid, probably volatile, emetic, powerfully purgative principle, and yield castor-oil. The leaves are used as a galactagogue, either applied to the breasts, or given internally. They are also used in skin diseases, abscesses, and ophthalmia.

For ricinus as an ophthalmic remedy in ancient Greco-Roman times, see **Palma Christi**, p. 9215, Vol. XII of this *Encyclopedia.*

Rickets. See **Rachitis.**

Ricord, Phillipe. A brother of Alexander Ricord (famous politician and naturalist) and himself the greatest syphilographer of all time. Born at Baltimore, Md., U. S. A., Dec. 10, 1800, of French parents, he removed in 1820 to Paris, for the purpose of studying medicine. In 1826 he received his degree, and settled at Olivet, near Orleans. In 1828, however, he removed to Paris, where he became a specialist in

venereal diseases. In 1831 he was made chief surgeon to the Hôpital du Midi for syphilitics, and in this institution he both practised and lectured brilliantly until his retirement in 1860. There came to him the highest honors, which here we need not mention.

Ricord's greatest service to humanity consisted in an absolute demonstration that "the venereal disease," so-called, was really three diseases. Until about the beginning of the 18th century it had been the universal belief that "the venereal disease" was only one affection, which, however, presented itself in a great variety of forms. About that time a number of doubters began to appear. But, in 1786, knowledge of the truth was much retarded by the well known experiment of John Hunter, which that famous surgeon performed upon himself. He inoculated his prepuce and glans with the virus of gonorrhea, developing not merely gonorrhea but also soft chancre and syphilis, so that he became convinced that all these three diseases were really only diverse manifestations of one and the same affection. The honor remained for the subject of his sketch, by a vast series of carefully conducted experiments, made from 1831 to 1837, to demonstrate the trinity instead of the unity of the so-called *morbus venereus*. Ricord also distinguished between the soft and the hard chancre, and divided the manifestations of syphilis into three stages—the well-known primary, secondary and tertiary. He made, however, the mistake of supposing that the virus of gonorrhea is not specific, i. e., that the discharge which is characteristic of that disease is simply one form of "catarrh."

Ricord died of cerebral apoplexy May 24, 1876.

Concerning the personality of the man, we can do no better than to translate the following passage from Albrecht von Graefe (quoted by Hirschberg): "Among all Frenchmen Ricord is plainly the most highly gifted and original. Imagine a man who does not walk, but always half dances, half runs, and forever laughs; who never makes a bad face or utters a word in earnest, but only cracks jokes, whom everyone would call a buffoon, if the man had not completely won everybody to him by a strange amiability and originality. Ricord lives like a prince, squanders every year the eighty to one hundred thousand dollars which he receives, and is the most popular person in Paris. He gives a course of lectures, in which he delivers himself of a continual chain of witticisms, but in which his highly intellectual accomplishments have full play—and these, of course, meet with far more opposition in Paris than elsewhere. They are always good-natured, harmless, kindly, never satirical witticisms. . . . . His patients take him by the hand. In the halls there rules a jocular, extremely

familiar tone. Every patient has a right to at least one joke; if Ricord, by his bed, does not accomplish one at least, then the patient calls out simply 'Ricord' without title or additions; Ricord appears, then makes a witticism. I might, in order to characterize the man, relate a hundred of his witticisms, but this would not suffice, because his entire appearance should go with him. I learned to know syphilis for the first time in Paris; I believe that in Berlin very little is known concerning this subject. I spend each morning in the Hôpital du Midi with the assistant of Ricord, who gives us a famous course. Thrice a week he sets before us the new patients, and we exercise ourselves in diagnosis; thrice a week he lectures to us at the bedside on the Ricordian system. In addition, I follow the lectures of Ricord. Ricord is indeed too dogmatic not to make a few mistakes, but the main things are true, and besides he has brought his field to the standpoint of scientific clearness. Then, too, one can only learn to know him in Paris, as his works all contain only individual matters, which, indeed, he himself now in part disavows."

Ricord's more important writings are as follows: 1. *Traité des Maladies Vénériennes.* (Paris, 1838.) 2. *De L'Ophtalmie Blenorrhagique.* (Paris, 1842.) 3. *Clinique Iconographique de l'Hôpital des Veneriens.* (Paris, 1842-1863.) 4. *Lettres sur la Syphilis.* (1851. 3d ed. 1863.) 5. *Leçons sur le Chancre.* (Paris, 1857. 2d ed., 1860).—(T. H. S.)

Riders. A free translation of the German "Reiter," or "Reiterchen," because of the degenerated crystalline fibres that in certain forms of cataract, appear to ride on the healthy tissues. See p. 1557, Vol. III of this *Encyclopedia.*

Riesenmagnet. (G.) Giant magnet.

Rifle-shooting, Visual requirements in. See **Marksmanship, Ocular relations of,** p. 7599, Vol. X of this *Encyclopedia,* also **Sport, Ocular relations of.**

Rigal, Jean Jacques. A well-known French surgeon, who devoted considerable attention to ophthalmology. Born at Cussac, Jan. 11, 1755, he received his medical degree at Montpellier. Settling at Gaillac, he became especially renowned for his skill as an operator. He died July 8, 1823.

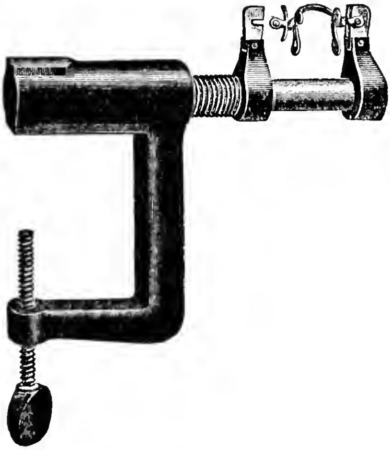
Rigal's only ophthalmologic writing is entitled "Considérations Pratiques sur les Maladies des Voies Lacrymales" (*Hist. et Mém. de l'Acad. Roy. de Toulouse,* Vol. XXX).—(T. H. S.)

Rigger, Fingerpiece mounting. An optician's tool used in repairing fingerpiece mountings. It securely holds any style of fingerpiece

mounting at the straps while making changes in the guards or springs, or adjusting the tension of spring. (See cut below.)

Riggs' disease. Pyorrhœa alveolaris, or alveolodental pyorrhœa. See **Dental amblyopia,** p. 3817, Vol. V of this *Encyclopedia.*

As a number of ocular diseases are said to result from this affection it may be added here that Brunelle and Ginsberg (*N. Y. Med. Record,* Sept. 11, 1915) point out that, as was the case with syphilis, before the discovery of spirochæta pallida, a veritable host of organisms have been held responsible for the condition known as pyorrhea alveolaris or Riggs' disease. Bass and Johns have suggested the name alveolodental pyorrhea as embracing the complete morbid process, whereas pyorrhea



Fingerpiece Mounting Rigger.

alveolaris, according to them, describes the advanced stages of the disease only.

The most recently described organism, held accountable for the condition, is *endameba buccalis* reported by Barrett and Bass and Johns. Up to the present time the organism has not been cultured, and in consequence the satisfaction of Koch's postulates has not been possible. This in turn has created skepticism in the minds of many as to the etiological specificity of the parasite. It is asserted by Bass and Johns that endameba buccalis is primary in its attack, that the countless other organisms which are present, are secondary invaders, and that this endameba is not present in normal mouths. Others take the opposite view, regarding the endameba as a possible secondary infective agent and sometimes present in normal mouths

Right-angle prism. A prism so attached to the stand of a microscope that it can be rotated either on a horizontal or vertical axis.

Right-eyedness. Dextrocularity. The conditions under which persons use the right eye (mostly because of its better vision) in preference to the left are discussed in *Mind*, Vol. IX, p. 93. 1884.

Righthandedness and visual conditions. Geo. T. Stevens (*N. Y. Med. Journ.*, Aug. 17, 1918) discusses this subject and draws our attention to the fact that the cerebral location for the control of the movements of the arm and hand is near the anterior portion of the hemispheres. Resulting from the more general use of the right hand this part of the left cerebrum at its anterior part is also correspondingly developed. A modification of the position of the orbit naturally results from this unequal development of the two sides of the cranium. The upper arch of the orbit is pushed outward and the axis of the cavity changed from a vertical to an oblique direction.

The globe of the eye is thereby tilted, its vertical meridian leaning outward toward the temple. This leaning of the vertical meridian of the left eye is extremely common, so common that its absence suggests, although it does not prove, lefthandedness.

This tilting outward of the vertical meridian of the eye does not imply any disease, insufficiency, or disability of any muscle or muscles controlling the movements of the globe. The eye simply maintains its normal relation to the orbit, while the orbit does not maintain its normal relation to the cranium. Of course the anomaly would occur to the right orbit in case of excessive use of the left hand during the period of the most rapid development of the individual. It is simply a question which orbit is forced outward by the unequal development of the cerebral lobes.

Rima. A crack, chink, or fissure.

Rima cornealis. Corneal cleft.

Rima palpebrarum. The slit or space between the eyelids.

Rimose. Rimous. Rimulose. Full of clefts, or crevices.

Rindenblindheit. (G.) Cortical blindness.

Rindenstaar. (G.) Cortical cataract.

Rinecker, Franz von. A German pediatrist, microscopist and physiologist, of slight ophthalmologic importance because of his graduation dissertation, "Die Entzündung der Gefäss-Nerven-und Glashaut des Auges und ihre Ausgänge." Born at Schlesslitz, Germany, Jan. 3, 1811, he received his medical degree at Munich in 1832. He taught and practised chiefly at Würzburg, and died Feb. 21, 1883.—(T. H. S.)

Ring abscess. See **Cornea, Ring ulcer of the**, p. 3440, Vol. V of this *Encyclopedia*.

Ring, Ciliary. The ring of tissue in front of the ora serrata, compris-

ing part of the ciliary body, and giving attachment to ciliary processes and muscle.

Ring, Conjunctival. A ring at the junction of the cornea with the conjunctiva.

Ring-dial. A portable sun-dial of annular form.

Ring, Glaucomatous. A light yellowish ring around the optic disk in glaucoma, indicating atrophy of the choroid. See p. 5411, Vol. VII of this *Encyclopedia.*

Ringlinse. (G.) Annular lens.

Ring, Löwe's. A ring in the visual field caused by reflections from the macula lutea.

Ring magnet. Inner-pole magnet. Mellinger's giant magnet. See p. 4257, Vol. VI; as well as p. 7582, Vol. X of this *Encyclopedia.*

Harrison Butler (*Br. Journ. of Ophthalm.*, p. 46, Jan., 1917) has modified this instrument and claims for the new design that it outclasses all the larger magnets for the extraction of metallic fragments from the eye. The advantages are: (1) The operation can be performed upon a patient lying upon the table. (2) There is no necessity to move him when the splinter has appeared in the anterior chamber. Butler has lost sight of the fragment in more than one case, and has been obliged to make the patient get up again, and place him before the magnet a second, or even a third, time. (3) There is no necessity to use a hand magnet. As soon as the splinter is seen in the anterior chamber, the circuit is broken, the anterior chamber opened, and the spicule removed with the spatula. (4) The power of the ring magnet at its center is great, and is under absolute control. (5) It is much easier to operate with the rods upon a motionless patient than to have to move his head this way and that before the Haab. (6) A patient sitting before the Haab may experience pain, and move at the critical moment; he may even faint from the pain.

The only valid objection to the magnet is that the force is considerable only at the center of the solenoid. In consequence, the eye must be kept in the center. The inventor never found any difficulty in placing the eye in this situation and keeping it there.

He has succeeded in removing pieces of steel from the cornea which were difficult to extract with a needle.

Ring, Maxwell's. Probably an image of the yellow spot (resembling Löwe's, but smaller and fainter), which apears as a faintly defined area or halo around the fovea, when the eye fixes and rests on a gray or homogeneous blue surface.

Ring-neck snake. Ringhals. A venomous serpent, a close relative of the cobra. It is so-called from the presence of two black bands across

the throat. This snake—*Sepedon hæmachates*—is widely distributed. In superficial appearance it resembles the American rattlesnake. The ringhals, when excited, exudes a quantity of venom, which drips down the fangs and lodges behind the abrupt, horny lower lip. Upon this the angry snake directs a blast of air through its extensible wind-pipe, with the effect that a jet of fine venom-spray is emitted toward an enemy. This jet may reach a height of six feet. W. C. Scully (*Atlantic Monthly*, p. 359, March, 1919) says, "That the eyes are aimed at, I have proved by experiment. If the poison reaches them, blindness—which may be permanent—results. The bite of the ringhals is highly venomous, but the snake appears to prefer disabling its enemy by means of the spray of venom."

Ring-opacity. See p. 1769, Vol. III of this *Encyclopedia*.

Ring sarcoma. See **Flat sarcoma,** p. 5223, Vol. VII of this *Encyclopedia*.

Ring scotoma. BJERRUM'S SIGN. ENLARGEMENT OF THE BLIND SPOT. Bjerrum's sign, a scotoma begininng at the blind spot, and gradually encircling the fixation spot, when first described, was supposed to be characteristic of the glaucomatous field. It has since been found in some cases of neuritis, resulting from disease of the accessory nasal sinuses.

von Szily (*Klin. Monatsbl. f. Augenheilk.*, Feb., 1913) discovered a ring-shaped scotoma developing from the blind spot in cerebral choked disk. A student, aged 25, was kicked on the head by a horse, while serving his military year. In December, 1911, he complained of haziness before his eyes and diplopia. The examination revealed bilateral choked disc, (without hemorrhages) and paralysis of the left abducens. The patellar reflexes were abolished; there was slight tremor of hands and legs and slight disturbances of equilibrium. Wassermann was negative. A cerebellar tumor was diagnosed, and, as at first normal vision commenced to fail slightly, punctures of the corpus callosum were made and 150 ccm. fluid emptied, with improvement of the subjective feeling of the patient and a slight receding of the choked discs. Later, the left blind spot area remained stationary; a ring-shaped scotoma developed in the right eye. The visual fields were examined with different methods, of which that of Bjerrum proved the most useful.

von Szily discusses the indications for a decompression operation and attributes the greatest importance to the observation of vision and the visual field. In this respect the paracentral scotoma, arising from the blind spot, with intact vision and relatively good contours of the visual field gains a special significance, as its progress may justify an operation before the appearance of other symptoms. In the author's

case the ring-shaped scotoma indicated the advisability of an operation.

Zade (*Archiv f. Ophthalm.*, 91, p. 159, 1916) observed a *peripheral ring scotoma* in a soldier who served an anti-aircraft cannon for months. Following this Zade examined a number of officers and soldiers in the aircraft service. He found five out of nine aviation officers had ring scotoma and a large percentage of those attending the machine guns. The scotoma, in most, extended from 35 to 50 degrees from the fixation point and was only a few degrees wide. He thinks that glaring will first affect the peripheral zone of the retina, this being physiologically weaker, as seen in pigmentary degeneration.

See, also, p. 1003, Vol. II, as well as **Perimetry** in this *Encyclopedia.*

Ring-shaped. See under corresponding **Ring** caption, as for *ring-shaped opacity* see **Ring opacity.**

Ring-shaped cataract. Annular cataract of Vossius. See p. 1769, Vol. III of this *Encyclopedia.*

Ring's mask. See p. 1652, Vol. III of this *Encyclopedia.*

Rings, Newton's. The colored rings seen on the surface of thin, transparent membranes, as soap-bubbles, due to chromatic aberration.

Ring ulcer. See **Ring abscess.**

Ringworm. Favus. See p. 5172, Vol. VII, of this *Encyclopedia.*

Rinne. (G.) A gutter; furrow; sulcus.

Riolan, Ciliary muscle of. These muscular fibres have nothing to do with the ciliary body, although the name might give that impression. This muscle is made up of a few bands of fibres running, in a distinct group, near the margin of the eyelid. See p. 346, Vol I, of this *Encyclopedia.*

Ripault's sign. Alteration in shape of the pupil when pressure is made on the globe, fixed after death but transitory in the living subject.

Ripe cataract. Mature cataract, ready for operation. See p. 1445, Vol. II, as well as p. 1583, Vol. III, of this *Encyclopedia.* For *ripening of immature cataract*, see **Artificial ripening of cataract,** p. 635, Vol. I of this *Encyclopedia.*

Ripplegrass. See **Plantago.**

Rischiaramento delle cicatrici della cornea. (It.) Removal of scars of the cornea.

Riseley, Stanley. A well-known ophthalmologist of Sheffield, England. Born in 1868 at Bristol, son of Henry Riseley, solicitor and ex-sheriff of that city, and a nephew of George Riseley, director of the Bristol Musical Festival, he graduated at Edinburgh University, and then settled in 1898 as ophthalmologist at Sheffield. In 1912 he was pres-

ident of the Sheffield Medico-Chirurgical Society, and, at the time of his death, was ophthalmic surgeon to the Sheffield Royal Hospital, and to Rotherham Hospital. He died Feb. 5, 1915, leaving a widow and five children.—(T. H. S.)

Risley's rotary prism. See p. 4692, Vol. VI of this *Encyclopedia*.

Ritratto secondo. (It.) Secondary image; an impression of an object upon the retina which remains for a certain time after light is withdrawn.

Ritterich, Friedrich Phillipp. A well-known German ophthalmologist. Born at Leipsic May 4, 1782, he received his medical degree at the University of his native town. He then studied ophthalmology exclusively at Vienna under Beer and Adam Schmidt. Returning to Leipsic, he there practised as ophthalmologist until his death. He was one of the founders (in 1821) of the Leipsic Eye Infirmary, and its director from 1821—1852. In 1828 he was made extraordinary professor of ophthalmology at the University, and, in 1847, Hofrath. For a long time he was wholly blind. He died Feb. 14, 1866.

He was a friendly, warm-hearted man, and liked by all who knew him, but he had very little ability as a teacher. His judgment and his operative skill, however, are said to have been of a high order.

His chief ophthalmologic writings are as follows: 1. *Jährliche Beiträge zur Vervollkommnung der Augenheilkunst.* (Bd. I, 1827.) 2. *Enumeratio Instrumentorum ad Tollendam Canalis Nasalis Obstructionem—Commendatorum et Depictorum.* (1830.) 3. *Die Heilanstalt f. Arme Augenkranke zu Leipzig zur Zeit ihres 25jäh. Bestehens.* (1845.) 4. *Anweisung zur Erhaltung des Sehvermögens.* (1847; 2 Aufl. 1852.) 5. *Das künstliche Auge.* (1852.) 6. *Zur Lehre vom Schielen und über das Anpassungsvermögen der Augen.* (1856.) 7. *Lehre von den Blutigen Augenoperationen am Menschlichen Körper.* (G. B. Guenther's *Lehre v. d. Blut. Operationen*, 1858.) 8. *Die Hornhautbeere, Staphylom der Hornhaut.* (1859.) 9. *Weitere Beiträge zur Vervollkommnung der Augenheilkunst.* (1861.)—(T. H. S.)

Rittmann, Alexander. A well-known German ophthalmologist. Born Feb. 16, 1827, in Mährisch-Trübau, he received his degree in medicine and surgery at Prague in 1856. For a time he was assistant to Arlt, in the Eye Clinic, afterwards settling in Brünn. From 1862 till 1870 he was chief of the Eye Division at the Brünn Hospital, and, after a number of other official positions, died Jan. 21, 1882.—(T. H. S.)

Rivalry, Retinal. The apparent alternate displacement of two figures by each other when viewed together, one by each eye.

Rivaud-Landrau, Louis. A French ophthalmologist. Born Mar. 25, 1817, at Poitiers, France, he received his medical degree in 1839. He

married a daughter of Dr. Parfait-Landrau, and at once joined his father-in-law at Poitiers in the practice of ophthalmology exclusively. In 1854, he, in company with Parfait-Landrau, removed to Lyons, where they two together founded a private Eye Infirmary, called *Maison de Santé Spéciale pour les Maladies Ophtalmique*. Rivaud-Landrau was especially renowned as an operator, yet, in addition, he wrote almost a score of articles which appeared in the *Annales d'Oculistique* from 1854-'62 inclusive. Parfait-Landrau, according to Hirschberg, discovered the condition now termed "synchisis scintillans." He died in 1874, while the date of the death of his father-in-law seems not now to be ascertainable.—(T. H. S.)

River fish. According to Pliny the elder and Dioscorides, the fat of any sort or kind of river fish would, if rubbed into the eyes, improve the visual acuity.—(T. H. S.)

Rivers, Edmund C. A well-known Denver ophthalmologist and otolaryngologist. Born in 1858, he received the medical degree in 1879 at the University of Maryland, Baltimore. For many years he practised his specialties at Denver, and was president of the board of trustees and professor of ophthalmology in the Denver and Gross College of Medicine, as well as vice-president of the board of directors and consulting oculist to the Denver Maternity and Woman's Hospital Association. He was drowned in Barr Lake, near Denver, Oct. 24, 1915.

The circumstances attending Dr. Rivers' death, as well as his salient characteristics are given in "*Ophthalmology*" (1915, pp. 432, 3) by Dr. Melville Black, as follows: "Dr. Edmund C. Rivers, of Denver, was drowned October 24th at 9:30 a. m. in Barr Lake, Colorado. He was returning with an attendant in a small boat from a sand bar in the center of the lake where he had been shooting ducks since sunrise. There was a strong wind blowing and the lake being a large one the waves were running about four feet high. The boat was formerly used exclusively as a rowboat but had been converted into a motorboat and the motor caused the rear end of the boat to sink rather low in the water. No one saw the accident. The boat was found only a short distance from the sand bar with the prow sticking up out of the water because of the weight of the motor dragging down the other end. He was accompanied by a young negro man, and their bodies were not recovered for several days. Dr. Rivers was not heavily clothed, having on a sweater and hip boots, no shells in pockets. The negro did not have his shoes on and wore his usual clothes. They were both good swimmers. Dr. Rivers was an unusually powerful man. He did not wear an overcoat in the coldest winter weather,

hence it is difficult to understand why he could not get to the boat and cling to it until assistance came, for the accident was discovered shortly after it occurred.

"Dr. Rivers was a bachelor with plenty of money and enjoyed living. He was very fond of outdoor life and the big sports that go with it. Cold and hardships had no terrors for him. He ate practically one meal a day, but that was a large one. I have heard him say that a turkey was an unsatisfactory bird because it was too large for one and not large enough for two. He was quick witted and very fond of "putting something over on the other fellow." He made one of the best toast-masters I have ever seen. For many years he took a keen interest in medical society and medical school affairs. He was dean of the Denver and Gross School of Medicine a few years before consolidation with the University of Colorado and had been president of our county and state medical societies. He had at one time or another been ophthalmologist to all our hospitals. He was a great reader and left a very fine general and medical library.

"His judgment in ophthalmology was conservative and sound, and was respected by his confreres.

"We shall miss him in more ways than one. On winter mornings as we in fur coats and in automobiles make our hospital visits we will miss seeing Rivers, no vest, coat wide open, pounding along on foot, arms swinging, face aglow, a perfect picture of power and energy as he completed a walk of six miles or more. We used to hail him and ask, won't you ride? and hear him smilingly refuse. We soon learned not to ask him to ride and were content to fling at him, 'how are you coming this morning, Rivers?' and never tire of his reply which was always different and always worth hearing. The last he ever gave me was 'poorly, poorly, I don't get enough to eat.' As far as known there are no photographs of our late friend extant."—(T. H. S.)

Riviére, Lazare. A celebrated Professor of Medicine at Montpellier, and follower of Paracelsus. Born 1589, died 1655. He is memorable to ophthalmologists because of the following passage, which occurs in his "*Praxis Medica*": "When a cataract cannot be dissolved by any sort of medicine, then the last resort is a surgical operation. If the cataract mass be thick and enclosed in a little membrane, it is thrust down into the depths of the eye with a needle (with which the eye has been penetrated) just as one opens a window. This operation is sometimes successful, but often not. However, if there is no hope in any other means, it is better, according to the opinion of Celsus, to try an uncertain remedy rather than none at all. Yet, because of its great uncertainty, the cataract operation should be per-

formed not by ordinary surgeons, but by quacks, who, for the sake of this practice, travel hither and thither; and, therefore, the choice of the time for and the kind of operation should be left to them too." —(T. H. S.)

Rivolta's disease. Actinomycosis.

Rivus lacrimalis. Same as *Lacus lacrimalis.*

Robert, Professor. A German ophthalmologist who lectured on his specialty at Marburg about the middle of the 19th century. He also had a private eye infirmary in that city. His ophthalmologic writings are as follows: 1. Ueber Subkutane Durchschneidung des Orbicularis und die Canthoplastik zur Heilung der Blepharophimosis, nebst Bemerkungen über die Subkutane Durchschneidung der Sphinkteren überhaupt. (*Jour. d. Chir. und Augenh.,* vol. 32, pp. 27-37, 1843.) 2. Angeborene Geschwulst der Sklerotica und Cornea des Linken Auges bei Gleichzeitig Angeborener Missbildung des Rechten Aeusseren Ohres und Naevus der Linken Wange. (*Ibid.,* pp. 38-42.)—(T. H. S.)

Robertson,* Charles Archibald. An American ophthalmologist. Born at Mobile, Alabama, Oct. 15, 1829, son of Archibald T., and Sarah Carnico, he received the degree of A. B. at Harvard University in 1850, and his medical degree at Jefferson Medical College. For a time he studied diseases of the eye and ear in Boston at the Perkins Institution and at the Boston Eye and Ear Infirmary, and, later, at the Wills Eye and Ear Hospital in Philadelphia. After a year and a half in Europe, he settled at Boston as ophthalmologist and oto-laryngologist, but in a very short time removed to New York City. For about two years he served with the Northern Army in the Civil War, but, having been retired on account of illness, he practised at Poughkeepsie, then at Albany. Here he remained until his death. He was ophthalmic and aural surgeon at St. Peter's Hospital, and to the Albany Hospital. He was also attending oculist at the Troy Hospital. He was one of the founders of the American Ophthalmological Society, a member of the International Ophthalmological Society, and of the American Otological Society. He married, in 1853, Ellen A. Fuller, of Cambridge, Mass. For nearly a year before his death he was confined to bed with chronic pleurisy, suffering much but complaining not at all. He died April 1, 1880.

Robertson's most important ophthalmologic writings are as follows: 1. *The Importance of Examining the Dioptric Media in Some Pathological Affections of the Eye.* (1865.) 2. *Glaucoma and its Cure.*

* Hirschberg, in his "*Amerikas Augenärzte,*" has it "Richardson."

Perturbation of the Olfactory Nerve following Extraction of Cata- by Iridectomy. (Trans. from the French, Nov. 1866.) 3. *Some Curious Reflex Phenomena After Injuries of the Eye.* (1870.) 4. *Remarkable Perturbation of the Olfactory Nerve following Extraction of Cataract.* (1873.) 5. *An Eye Case in the Courts.* (1874.) 6. *Pigmentation of the Retina.* (1877.)—(T. H. S.)

Robertson, Douglas Moray Cooper Lamb Argyll—generally known as Argyll Robertson.* A famous British ophthalmologist, discoverer of the "Argyll Robertson pupil," inventor of scleral trephination for glaucoma, and discoverer of the action on the accommodation (not on the pupil) of an alcoholic solution of calabar bean—a remedy which he introduced into ophthalmology. The son of Dr. John Argyll Robertson, who, in 1848, was president of the Royal College of Surgeons of Edinburgh, and brother of Dr. Lockhart Robertson, he was born at Edinburgh, Scotland, in 1837. He studied medicine at Edinburgh and St. Andrews, and from the latter institution received his degree in 1857. He then studied ophthalmology in Prague under von Arlt and in Berlin under von Graefe. Settling as ophthalmologist in Edinburgh, he was very soon known as a brilliant operator and clear and forceful writer. In 1862 he became a Fellow of the Edinburgh College of Surgeons. Five years later he was elected assistant ophthalmic surgeon to the Royal Infirmary; three years later, surgeon; and, in 1882, surgeon-in-chief. In 1897, at the time of his retirement from hospital work, he was made consulting surgeon of the institution which he had served so long. In 1886 he was president of the Royal College of Surgeons of Edinburgh, in 1893 and 1894 president of the Ophthalmological Society of the United Kingdom. He was surgeon-oculist-in-ordinary in Scotland to Queen Victoria and to King Edward, and in 1896 received the degree of LL. D. *honoris causâ* from the University of Edinburgh.

In 1904, because of a chronic pulmonary trouble, Robertson retired to his country place, "Mon Plaisir" in the Island of Jersey. On his departure from Scotland he was presented with his portrait painted by Sir George Reid—the kindly remembrance of many professional friends. Though his health continued to fail, even after his retirement to the mild and genial climate of Jersey, he attended now and then an ophthalmologic congress, and, at last, made a visit to India. While in that country he died, at Wondal, Jan. 3, 1909, aged 71. In accordance with his wish, his body was cremated. This occurred, almost

* Sometimes misspelled with a hyphen. "Argyll" is not a part of the surname.

immediately after his death, on the banks of the river Gondli. The religious services were conducted by the Rev. G. S. Stevenson, of Edinburgh, himself a physician, and the pyre was lighted by Robertson's host, the Thakur of Gondal.

Dr. Robertson's estate was proved at £30,002.

Concerning the personality of Dr. Argyll Robertson we shall be pardoned if we quote from the many appreciations published after his death. For example, from a writer in the *Annals of Ophthalmology* for April, 1909: "Argyll Robertson was a type of gentleman and physician that is becoming more and more difficult to find every year. The old school to which he belonged is, unfortunately, yielding to the relentless pressure of the newer, more aggressive, less substantial and, we might say, less desirable school of the present day, in which commercialism is playing an ever increasing part."

Again, a writer in the *Ophthalmoscope* for February, 1909, holds the following language: "In many ways Argyll Robertson was an admirable Crichton. Tall, handsome, traveled, popular, courteous, an accomplished linguist and an acceptable chairman, he had always been a notable athlete. Not so many years ago he was one of the most prominent amateur golfers. He was a member of the Royal Bodyguard of Scottish Archers, one of the most ancient, honorable, and exclusive corporations in the United Kingdom. In 1882 he married the fourth daughter of W. M. Frazer, of Findrach and Tormavein, Aberdeenshire, a charming lady well known in Edinburgh society. There is no family."

The following appreciation was written by Sir Anderson Critchett for the *Ophthalmoscope:* "For nearly forty years I enjoyed the friendship of Argyll Robertson, and I know only too well that his loss will leave a void which no other personality can fill in the hearts of all who loved him. The handsome intellectual head and splendid frame once seen could never be forgotten, for he was the ideal representative of well-balanced mental and physical vigor. The watchwords of his life were courage, duty and honor, and he possessed in a marked degree that old-world courtesy of manner which is too seldom to be found in this age of hustle, advertisement, and self-assertion. Those who were present at the International Ophthalmological Congress held in Edinburgh under his presidency in 1894 will recall the blended dignity and geniality with which he controlled the meetings, and the generous hospitality extended to one and all by his fair partner and himself.

In more recent times he was asked to preside at meetings during similar Congresses held at Utrecht and at Lucerne, and we his col-

leagues rejoiced to see him occupy that exalted position, for we felt that Great Britain could not possibly have a grander or more efficient representative.

He was an exceptionally brilliant and successful operator, fertile in initiation and resource, possessing that firm but gentle power of manipulation which begets such perfect confidence in the patient, while those who watched his skilful operations might well exclaim in the words of his gifted countryman 'the hand of Douglas is his own!'

The only occasion within my knowledge on which he hesitated to face the surgical situation was when it became necessary to operate on his brother, the late Dr. Lockhart Robertson, for cataract, and I felt much honored when he asked me to relieve him of the fraternal responsibility.

It would be impossible to find a more perfect example of the *mens sana in corpore sano*, for with his great intellectual power and deep scientific knowledge, he combined a love of manly sport. He was an excellent shot, he belonged to the Archers of the Royal Body Guard, and his wife's most cherished ornament was a necklace formed of the numerous gold medals he had won at golf.

Although he could show unflinching firmness and force of character when the occasion demanded those qualities, he was never happier than when in genial companionship, he could throw off the fetters of professional responsibility, and heartily join in the fun and frolic of the moment.

He had a keen sense of humor, and I shall never forget the leonine roar of mingled appreciation and reproach with which he received my suggestion that it was far better to be an Argyll Robertson pupil than to have one. I sincerely hope that his sorrowing friends and former students may be able to provide some permanent memorial of this great and good man, either in connection with Edinburgh University or with the Ophthalmological Society of the United Kingdom; but the splendid work which he has done has already placed him in the ranks of the immortals, for he has left a reputation and a name which cannot die."

Mr. Simeon Snell, president of the British Medical Association, wrote to the *Ophthalmoscope* as follows: "I gladly accede to the request of the Editor of the *Ophthalmoscope* to say a few words respecting my esteemed friend, the late Dr. Argyll Robertson, whose death must have come as a deep personal loss to many. I think I must have known him for something like 25 years, and have been the recipient of many kindnesses at his hands. His striking and impressive personality was familiar to all of us, his courteous and dignified

conduct as chairman was shown, not only when presiding over the Ophthalmological Society, but also as President of the International Ophthal. Congress when it met in Edinburgh in 1894. I only saw him operate on one occasion, when he performed extraction of cataract in an exceptional manner. What struck me particularly was, at a time when all were not as careful of the instruments as they are at the present day, that he was most scrupulous as to every detail. For my part I am not likely ever to forget the kindness he showed me during the past year. He early wrote to me expressing the pleasure he felt that I was to occupy the post of President of the British Med. Assn., the first time, as far as these islands are concerned, that an ophthalmic surgeon has filled that position, and he stated his intention of leaving his retirement in the island of Jersey to come to Sheffield to support me by his presence, which he accordingly did, and took an active part in the meetings of the ophthalmic section. He also attended and supported me at the luncheon I gave at the Royal Infirmary to ophthalmic surgeons visiting Sheffield. This was on many accounts a most memorable occasion; besides Sir Henry Swanzy, the president of the section, among my guests were Prof. Fuchs, of Vienna, and Prof. Axenfeld, of Freiburg, and others well known amongst us, numbering 50 in all. The presence of two veterans lent especial interest to the occasion, these being Mr. Pridgin Teale, my greatly respected old master, and Dr. Argyll Robertson, whose loss we are now mourning. He accompanied the party to the ophthalmic wards and operating theatre, and here an incident occurred which is worth the telling. After the others had left, he returned to speak to the sister in charge of the wards, saying that he was glad to hear she had worked so long with me and hoped she would continue to do so for many years; everything was in such perfect order that he felt sure it must give me great pleasure to have one working with me so long and so well. Needless to say that this, so characteristic of the man, has been treasured as a sort of red letter day in her memory.

Always bright, always courteous, his fine, handsome appearance made him a most noticeable figure in the social functions of the meeting. Apparently in the best of health, and keenly interested in all that was going on, no one would have thought he was so soon to be removed from us. To Mrs. Robertson goes out the warmest sympathy in her deep sorrow."

The following interesting notes were also contributed to the *Ophthalmoscope* by Dr. George Mackay, ophthalmic surgeon to the Edinburgh Royal Infirmary: "I sadly avail myself of the opportunity of adding some personal reminiscences of my old chief Argyll Robertson, with

whom for more than twenty years I was intimately associated. I had it from his own lips that though his father practised as a surgeon and as an ophthalmic surgeon in Edinburgh, he died before his son was able to join him in professional work, and his family were left poorly off. Discussing one day with Dr. Robertson the pecuniary difficulties which confront a young specialist unsupported with private means, he surprised me by the remark that no one could realize that better than himself, for he had something less than three figures as his patrimony when he decided to start practice as an ophthalmic surgeon in his native city. The venture was all the more hazardous because at that time the public recognition of specialism was scarcely assured, and not a few general practitioners were strongly opposed to it. I doubt whether the experiment could have been successful if he had not for a time acted as assistant to the late Prof. Hughes Bennett, and under his auspices Argyll Robertson was the first to teach practical physiology in the University of Edinburgh. That, however, was not to be his career. He soon became attached to the Eye Dispensary of Edinburgh and to the ophthalmic department of the Edinburgh Royal Infirmary, and devoted himself to clinical work.

My earliest personal recollections of Dr. Robertson go back to the summer session of 1882, when he lectured daily at Surgeons' Hall. Instruction in eye diseases was not at that time a compulsory part of the medical curriculum. It was extra-mural and optional, but no serious student failed to attend it. Its voluntary character was not an unmixed advantage to the lecturer, since it secured for him not only a more attentive audience, but also left him greater freedom in his method of dealing with the subject. Dr. Robertson's systematic lectures actually provided a fuller course than is required by the present regulations. His lectures were delivered from very full, if not complete, notes, and spoken rather deliberately. Needless to say, the best of order and discipline was maintained. I cannot recall any rowdyness or levity in that class-room.

The opportunities for clinical instruction in the Royal Infirmary at that time were scarcely equal to the systematic part of the course. As the usual curriculum only extended over 4 years, senior students had great difficulty in finding time to attend extra classes, and my contemporaries will recall how in endeavoring to avail ourselves of such opportunities as existed for studying 'specialties,' we led the strenuous life, and the best attended ophthalmic cliniques were those which Dr. Robertson held upon Sundays.

Many an Edinburgh graduate who does not now profess to know much about 'eyes' can never forget the handsome physique, the

finely chiselled features, and the dignified presence of the lecturer in ophthalmology. He carried about with him an unmistakable air of refinement. In his voice, his gesture, and his attire there was a characteristic note of distinction.

A fine artistic sense enabled him to accomplish many things neatly and well, and he was not unconscious of it. One might even venture to say that he satisfied the Scottish requirement of having 'a guid conceit o' himsel',' without descending into vanity.

Again and again I have heard old students refer to him as their *beau-ideal* of a courteous clinical surgeon. Sympathetic and kindly in his mode of addressing the poorest patient, he did not hesitate roundly to scold the careless or inattentive parent or guardian, where procrastination, neglect, or abuse of remedies had aggravated a malady, or imperilled the eyesight of the sufferer.

In those days tying up the eyes for fear of cold, and the frequent application of poultices made of decomposable material were commonly practised by persons not only without, but within, the profession, who should have known better. Against all such 'abominations' Argyll Robertson stoutly protested, and I feel certain that the comparative rarity with which such cases now present themselves in the clinique to which I have succeeded is largely due to his good influence. In cases where counter-irritation seemed indicated, a favorite remedy of his (and of his predecessor, Mr. Walker) was the application of solid nitrate of silver to the moistened surface of one or other eyelid. His skill as an operator was universally acknowledged. He was not only dexterous, but taught us to be ambidextrous. By the time I was associated with him he had adopted Listerian methods of antisepsis, his favorite germicide being a solution of perchloride of mercury. He occasionally horrified some of us, whose training was more modern, by placing the ivory handle of a Graefe's knife or an iris repositor between his lips as a convenient resting-place in the middle of an operation; but he committed the outrage with such quiet dignity that one scarcely ventured to protest, and after all, his results were excellent. It astonished some of his students latterly that he did not assist his vision with spectacles at operations, but he was anisometropic, the right eye emmetropic, the left myopic. For external examinations he commonly employed a small magnifying glass before the right eye.

As the late Prof. Jowett observed: 'We are none of us infallible, not even the youngest of us,' and Argyll occasionally made mistakes like the rest. An old friend of mine, a Highland gentleman, once consulted him about some ocular discomfort. I know not whether

it was his grey-bearded visage and Highland cloak, with perhaps an odor of Harris tweed which suggested to the mind of Dr. Robertson, not merely the 'mountain and the moor,' but some partiality for 'mountain dew,' but the patient was hugely diverted when the consultant concluded his examination by gravely shaking his head, raising his finger, and saying: 'That whisky, that whisky!' The diagnosis had certainly gone astray, for my informant was a total abstainer. In general, one was impressed by the soundness of his judgment, his retentive memory, and his vast experience.

To his wholesome love for manly exercise, his success as a golfer, an archer, and a curler, I need not further refer. But I cannot conclude these brief notes without endeavoring to express the sense of profound sorrow with which the news of his passing away has been received by all with whom he was associated in the city and the land which he adorned. The sympathy of all who knew him goes out to the bereaved wife, to whom he was so devotedly attached. He leaves behind him the precious memory of an honored name and an inspiring example of professional life and conduct.''

The following was contributed by still another intimate acquaintance of Dr. Robertson: ''As an operator Argyll Robertson was beyond compare. He knew nothing of 'nerves'; and brain, eye, and hand collaborated so perfectly that it was a delight to watch him at work. His teaching, so clear, so well-arranged, was followed by a large class of students, although ophthalmology was not at that time included in the curriculum of necessary medical studies at Edinburgh.

But deeply interested, and much engaged, as Robertson was in his profession, he also took interest in less serious pursuits. He was an archer of that distinguished corps, The Kings' Body-guard for Scotland. He was a good sporting shot. He was fond of travel, but golf was his chief recreation, and five times he won the gold medal of the Royal and Ancient Club, and three times the gold medal of the Honorable Company of Edinburgh Golfers. To golf he attributed much of his good health and of his enjoyment of life, and it was not his experience that it had interfered with his professional success. On the contrary, he used to tell how, soon after he commenced practice, he was consulted by a gentleman on account of his daughter's strabismus. Robertson advised operation, to which the father promptly assented. At the final visit the gentleman said he supposed Dr. Robertson did not know what it was had caused him to bring his daughter to him. Robertson said he did not, and had been wondering how it had come about, for he had not even an acquaintance in the part of Scotland from which the gentleman came. 'Well,' said the

gentleman, 'I brought my daughter to you because I saw you play such a steady game on the St. Andrews links the day before our first visit. I enquired who you were, and made up my mind at once.'

We have spoken of Argyll Robertson as the original observer, the brilliant operator, the able teacher, the true sportsman, the keen golfer. But he was more. He was one who in the highest degree maintained the honour, the dignity, and the finest traditions of our profession. Scrupulous in his dealings with his patients, and scrupulous in his relations with his professional brethren, imbued with a strong sense of duty, he was in all respects upright and straightforward. His was a charming personality. Of strikingly handsome appearance, he forthwith won the favour of all with whom he came in contact by his courtesy and sympathy. But when circumstances called for it no one could be more firm, yet without offence, in maintaining what he held to be the right. A delightful companion, with a keen appreciation of humour, his merry laughter filled the air. He was hospitable and generous to a fault. And, above all, he was a loyal and most affectionate friend, and many indeed there are who were proud to be able to claim his friendship, and who will look back upon it as one of their most cherished possessions."

The writer has quoted at length these various appreciations of Argyll Robertson, because he believes that the greatness of the man is an absolute justification for so doing.

Robertson was not a prolific writer. The complete list, in fact, of his ophthalmologic compositions is as follows: 1. The Calabar Bean as a New Ophthalmic Agent. (*Edinburgh Med. Jour.; London Ophthalm. Jour.*, 1863.) 2. On Eye Symptoms in Spinal Disease. (*Edinb. Med. Jour.*, 1869, '70.) 3. Trephining the Sclerotic, a New Operation for Glaucoma. (*Roy. Lond. Oph. Hosp. Rep.*, viii, 404; 1876.) 4. Diphtheritic Ophthalmia. (1870.) 5. Albuminuric Retinitis. (1871.) 6. Tenotomy of the Rectus Superior. (1873.) 7. The Operation for Entropium. (1883.) 8. A Case of Filaria Loa. (1890.) —(T. H. S.)

Robertson, John Argyll. A well-known British surgeon, father of the much more famous Douglas Argyll Robertson, himself a distinguished operator, and the first compiler of a comparative table of statistics of the cataract operation. The dates of his birth and death are not procurable. He was, however, surgeon to the Eye Dispensary at Edinburgh, and lecturer on surgery at the Edinburgh University. He wrote on iritis, amaurosis and the cataract operation. His most important article is entitled "Observations on Extraction and Displacement of the Cataract, with Tables Showing the Relative Success from

the Performance of These Operations'' (*Edinburgh Journal,* No. 131, XLVII, pp. 378-390).—(T. H. S.)

Robertson's pupil. See **Argyll Robertson pupil,** p. 567, Vol I; also pp. 10580 and 10756, Vol XIV; and under **Tabes dorsalis,** of this *Encyclopedia.*

Menninger (*Am. Journ. of Syphilis,* April, 1919) reports a case of *alcoholic Argyll Robertson pupil* and other reflex changes commonly associated with neurosyphilis in a patient not suffering from neurosyphilis, or from influenza, or from dementia præcox. The only demonstrated etiology was acute alcoholism. With the fixed pupils there was a speech defect, a paretic facial expression, tremulous tongue and hands, unequal knee and ankle jerks, and a rather defective memory. Altogether this made a fairly typical picture of ''alcoholic pseudoparesis.''

Rasquin and Dujardin (*Archives Médicales Belges,* 73, No. 1, Jan., 1919; abs. *Journ. Am. Med. Assocn.,* June 7, 1919) assert that the discovery of the Argyll Robertson sign calls at once for making out the balance sheet as regards syphilis. It may be the only sign of the disease and the patient may not be aware that he has it and may feel perfectly well. Nevertheless he must be told of the danger in which he stands, and the urgent necessity for treatment must be impressed on him as the only chance for him to escape some severe nervous affection, general paralysis, for example. The balance sheet can be drawn with great precision nowadays by the data obtained from examination of the blood, spinal fluid and the reaction to luetin. We can thus form a kind of biologic formula which can be compared with the typical formulas of the principal syphilitic nervous affections, and thus foretells the outcome. If the Bordet-Wassermann test of the blood is negative, reactivation must be tried. If this is negative, then lumbar puncture must be done, and only when all of these give a negative response are we justified in keeping the patient merely under surveillance. When the findings in the spinal fluid are seen to be exactly like those with grave nervous affections, the patient becomes convinced of the desirability of treatment. These old forms of syphilis are often very slow in responding to treatment, even quite active. As the reactions return to normal under treatment, the patient will understand better and will submit more docilely to our therapeutic efforts. By comparing the biologic formulas from time to time we can supervise conditions as they improve and further convince the patient of the wisdom of thorough treatment.

Robinia pseudacacia. False acacia. The common locust-tree of North America. Various parts of it are used by the eclectic physicians. The root and the inner stem-bark are used in catarrh, though both

are aero-narcotic poisons. The root contains (besides albumin, tannin, sugar, starch, etc.) robinic acid, asparagin, and robinin. Cases of poisoning are recorded in children who had eaten the root, with symptoms like those of belladonna intoxication.

Rochester's sign. See p. 926, Vol. I of this *Encyclopedia.*

Rochon's prism. A *double-image prism* (q. v.), in which only the extraordinary ray is deviated; the ordinary ray proceeding without deviation. It consists of two prisms of calcite (q. v.), or quartz, of the same angle cut so that the refracting edge in one is parallel to the optic axis and in the other perpendicular to it. See also **Wollaston's prism.**—(C. F. P.)

Rocket. *Brassica eruca.* A decoction of rocket leaves was, in ancient Greco-Roman times, employed in a general way as a "strengthener" of the eyes.—(T. H. S.)

Rodagen. A preparation of the milk of goats from which the thyroids have been removed: used in exophthalmic goiter.

Rodent ulcer, Jacob's. CANCROID ULCER. This disease, a slowly progressive ulcer of the face, not uncommonly involves the eyelids. Although it is histologically a carcinoma it is often described as a form of epithelioma. Clinically it represents features which serve to distinguish it from epithelioma. See **Cancroid ulcer,** and particularly p. 6697, Vol. IX of this *Encyclopedia.*

Rodent ulcer, Mooren's. See p. 3405, Vol. V of this *Encyclopedia;* also **Ulcus rodens (Mooren).**

Rodger, Anderson. A wealthy English shipbuilder, once Provost of Greenock. In 1894 he founded the Greenock Eye Infirmary. He died in 1909.—(T. H. S.)

Rodgers, John Kearney. A famous American surgeon, of much importance in early American ophthalmology. Born in New York City in 1793, he received his training in the liberal arts at Princeton College, and afterwards studied medicine with a preceptor, Dr. Wright Post, in New York. In 1816 he received his degree from the College of Physicians and Surgeons. After a term as house surgeon at the New York Hospital, he proceeded to London in company with Dr. Edward Delafield. Soon these two were greatly interested in ophthalmology, and, returning to New York, they, in collaboration with a number of others, established in 1820 the New York Eye Infirmary. For very many years Dr. Rodgers was surgeon to this institution, and some of the more important later ophthalmologists—for example, Cornelius Rea Agnew—were students (and sometimes protegés) of his.

Rodgers's chief performance was the tying of the left subclavian artery (in 1845) within the scaleni muscles—a procedure which he,

so far as I have been able to ascertain, was the first to execute upon the living human subject. As an operator on the eye, he was swift, bold, and brilliant. He wrote but little, his most important paper being "Ligature of the Left Subclavian Artery within the Scalenus Muscles for Aneurysm" (1846).

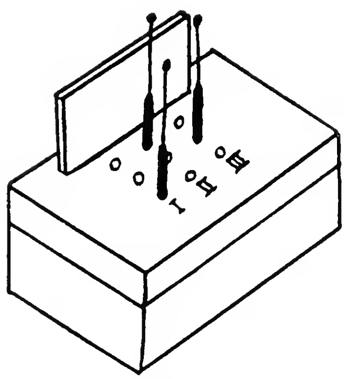
He died in 1851, of "phlebitis of the liver, followed by peritonitis." —(T. H. S.)

Rod, Maddox. See p. 7577, Vol. X of this *Encyclopedia.*

Rodriguez, Juan Sixto. A famous Spanish surgeon of the latter half of the 18th century, who devoted considerable attention to diseases of the eye. He was professor of surgery at the University of Seville, surgeon to the navy and to the royal family, and Fellow of the Royal Society of Medicine. His chief ophthalmologic writing was *"De la Fistula Lagrimal Completa y su Método Curativo"* (Seville, 1789).—(T. H. S.)

Rods, Retinal. Rods of the retina. See **Retina**; also p. 5962, Vol. VIII of this *Encyclopedia.*

Rods, Wolff's. See p. 3829, Vol. V of this *Encyclopedia.*



Wolff's Rods for Testing Perception of Depth.

Rod test. See p. 7577, Vol. X of this *Encyclopedia.*

Rod-vision. See **Darkness-acuity,** p. 3749, Vol. V of this *Encyclopedia.*

Roentgenograph. Roentgenogram. A Röntgen ray photograph.

Roentgenography. See **Radiography.**

Roentgenoscope. The fluoroscope; an apparatus for examining the body by means of the fluorescent screen excited by the Roentgen rays.

Roentgen rays. See **X-Rays** and **Radium**; also **Radiography.** The reader is, however, particularly advised to consult **Localization of ocular foreign bodies,** p. 7503, Vol. XI of this *Encyclopedia.*

In addition to the matter found under the captions above referred to it may be said, as Villasevaglios (*Archivio di Ottalm.*, 23, p. 461, 1917) pointed out in his extensive monograph on the subject, that the affections recognizable by means of the X-rays may be grouped as follows: (1) Intracranial processes and anomalies of formation of the cranium which determine atrophy of the optic nerve, dealing particularly with the tumors and affections which increase the cerebral pressure, with the affections of the hypophysis, and with cranial deformities, particularly the oxycephalic syndrome. (2) Lesions of continuity of the orbital walls and of the base of the cranium, which produce ocular changes, such as atrophy of the optic nerve, muscular paralyses, etc. (3) Anomalies of shape, destructions, hyperostoses and other tumors of the orbital walls. (4) Diseases of the sinuses which may be in relation with the orbit (frontal sinuses, ethmoids, etc.). (5) Foreign bodies of the eyeball and of the orbit. Eight personal cases reported with the paper include one of hypophyseal tumor, one of acromegaly, one of oxycephaly, one of tumor of the inner lateral region of the left orbital cavity, one of tumor of the left frontal sinus, one of sinusitis and two of metallic foreign bodies.

To what has been said as to the therapeutic value of the Roentgen rays, W. A. Pusey (*Jour. Am. Med. Assocn.*, July, 1913) has added that the effects of Roentgen rays on cancer tissues and clinical experience indicate the use of the agent in cutaneous epitheliomas, and in localized inoperable cancers near the body surface; and further the same facts constitute a logical demand that Roentgen rays be used as a measure of prophylaxis after operations on localized cancers near the surface of the body. Experience has shown that in cases in which the disease has become widely disseminated, and in cancers in the deep cavities of the body, Roentgen rays are practically without avail.

Rognetta, Francesco. A well-known Italian ophthalmologist, who spent the most of his professional career in Paris. Born at Reggio, Calabria, Sept. 26, 1800, he received his medical degree at Naples, and for a time was privatdocent in that University. For political reasons he removed to Paris, where he began to practice in 1833, becoming in a short time a most influential personage. According to Pagel, he it was who introduced operative ophthalmology into France—a statement which is strongly objected to by Hirschberg, and which, undoubtedly, is an exaggeration. He established a free course in ophthalmology at the Ecole Pratique, and was an esteemed collaborator on the *Gazette Médicale* and the *Gazette des Hôpitaux*. He was also prominent as a medico-legal expert. He died of anthrax while visiting Naples, Sept. 2, 1857.

In addition to a number of works on legal medicine and the surgery of the bones, he wrote or edited: 1. *Traité Pratique des Maladies des Yeux par Scarpa.* (Edited and elaborated by Rognetta, Paris, 1839.)

2. *Cours d'Ophtalmol. ou Traité Complet des Maladies de l'Oeil,* etc. (Paris, 1839.) 3. *Traité Philosophique of Clinique d'Ophtalmologie,* etc. (Paris, 1844.)—(T. H. S.)

Rohault, Jacques. A Cartesian of the 17th century, who was one of the first, but not the very first, to promulgate the doctrine that a cataract is not a pellicle of inspissated humor, seated in front of the lens, but the lens itself in a more or less opaque condition. The passage in which the statement occurs is found in his work entitled "*Physics*" (1672), and runs as follows: "Cataract is not a skin which forms in front of the crystal, as has been long believed, but rather an alteration in the crystal itself, which has lost its transparency." The first to announce this, of course the true, doctrine, was probably Quarré (1643-1650?); the first, however, to demonstrate the theory by actual anatomical dissection was Rolfinck, in 1656.—(T. H. S.)

Rolando, Lorenzo. An 18th century naval physician of Spain, who, in 1755, invented a serrated forceps for the extraction of the central portion of after-cataracts.—(T. H. S.)

Rolfinck, Werner. A distinguished anatomist, botanist, chemist, and physician, and the first important supporter of William Harvey, as well as the first to demonstrate by actual dissection that the natural position of a cataract is, actually, in, not in front of, the crystalline lens. The son of a well known professor and the nephew of the celebrated Schelhammer, he was born at Hamburg, Germany, Nov. 15, 1599. He studied philosophy at Wittenberg, and medicine there and at Leyden. After a number of journeys to England, France, and Italy, he studied medicine again, this time at Padua, where he received his professional degree. He held in succession a number of notable positions—the chair of anatomy at Wittenberg; the chair of anatomy, surgery and botany at Jena; the directorship of the botanical garden at the same institution, etc. He founded at the Jena University a laboratory and an anatomical theater—unusual institutions in those times. He wrote a very large number of articles and dissertations, but nothing at all of a longer character.

Ophthalmologically, he is very important indeed, because of the aforesaid demonstration by him (in 1656) of the true situation and nature of cataract. Quarré, a little before this date, had theoretically taught, but not anatomically demonstrated, the same great truth.

Rolfinck was an anatomical enthusiast. Indeed his activity in this

matter seemed to be unlimited. As a consequence, in parts of Germany today there is found in the folk's language a verb "to rolfinck" (rolfincken). It means to rob a grave for anatomical purposes. (*Cf.* the English verb, "to Burke.")

Rolfinck died May 6, 1673.—(T. H. S.)

Roller forceps. See **Trachoma,** and p. 5256, Vol. VII of this *Encyclopedia.*

Rollet's operation. For blepharoplasty. See p. 1089, Vol. II of this *Encyclopedia.*

Rollmuskel oblique. (G.) The superior.

Rollpinzette. (G.) Roller forceps.

Roman coriander. *Nigella sativa.* The same as pepper-wort and bishop's-wort. A decoction of the bruised plant was regarded, in ancient Greco-Roman times, as a remedy for epiphora.—(T. H. S.)

Romberg's sign. An indication of tabes dorsalis; swaying of the body when standing with the feet close together and the eyes closed.

Romershausen's eyewash. This is a weak tincture of fennel seed diluted with five times its volume of water.

Röntgen rays. See **Roentgen rays.**

Röntgenstrahlen. (G.) Roentgen rays.

Rood, Chromatic circle of. A scheme by which the artist can easily remember color contrasts. See **Chromatic circle of Rood,** p. 2191, Vol. III of this *Encyclopedia.*

Roosa, Daniel Bennett St. John. A celebrated American ophthalmologist, chief of the founders of the New York Post-Graduate medical school and for many years the president of that institution. Born at Bethel, N. Y., April 4, 1838, of old Colonial stock, he attended for a single year at Yale, but left that institution because of ill-health. Afterwards he received from this institution the degree of A. M., *honoris causa.* The year after he left Yale he entered the Medical Department of the University of New York, from which institution he received his degree in 1860. He served for some years in the Federal Army as assistant surgeon of the 5th New York volunteers, and was for a time house surgeon at the New York Hospital. Then, for a year, he studied ophthalmology and otology in Berlin and Vienna. For a very brief period, he served in the U. S. Army again, and having completed the service for which he had been engaged, he settled (in 1863) in New York City as ophthalmologist and otologist exclusively. For five years he was professor of ophthalmology and otology at the University of Vermont, and from 1866 till 1894 he held the corresponding chair at the University of the City of New York. He was a member of the American Ophthalmological So-

ciety and a corresponding member of the Medico-Chirurgical Society of Edinburgh, etc. He was president of the New York Academy of Medicine and of the New York State Medical Society, and was twice president of the American Otological Society and once president of the International Otological Society. As stated above, he was chief of the founders of the New York Post-Graduate Medical School, in which institution he taught from 1883 until his death. He was also one of the founders of the Manhattan Eye and Ear Hospital, of New York, and of the Brooklyn Eye and Ear Hospital, Brooklyn. In both of these institutions he was a surgeon for many years. In 1880 he received the degree of LL. D. (*honoris causa*) at the University of Vermont.

Dr. Roosa was a short man, with a broad, strong body, a very large head, and small feet and hands. His hair, in his later life, was somewhat gray; it was always heavy and wavy. The eyes were blue, crystal-clear, steady and penetrating. He always wore a beard trimmed to a point, and this, as well as his eyebrows, was very heavy. He was a dainty dresser, and immaculately clean, even in the days before asepsis. He usually wore a cut-a-way coat, except in his private office, when he had on, almost invariably, a velvet jacket. He would write, as a rule, with nothing but a quill pen, and almost always in such a way that hardly anyone could read the letter or prescription.

Roosa had a double cataract extraction (without iridectomy) performed on himself by Panas, of Paris. The result was most satisfactory, with a perfectly central, circular pupil in each eye. No one could tell he had had such an operation save by close inspection that might detect the tremulous irides and the magnification of the anterior segment by the strong cataract lenses. None of his patients, at least, suspected that he had ever had cataract or that he had had an operation performed overseas.

Dr. Roosa was a very positive man, and he did not like to be crossed. In matters of professional opinion, especially, he was, as he himself sometimes very laughingly admitted, somewhat "sot in his ways." He did not, for example, believe it proper to correct the lower degrees of refractional errors, and, shortly before his death, there appeared in the *Journal of the American Medical Association* an article from his pen to that effect. He further did not believe in the propriety of muscle tests, and would not permit such a thing as a phorometer to stand in his office. Bringing from Paris, in 1890, a Javal ophthalmometer, he informed his friends and assistants that this instrument had rendered cycloplegia "a matter of the far past." Nor did he often afterwards employ a cycloplegic. In fact the use of

a cycloplegic by any of his assistants was apt, for years, to evoke a distinctly spoken and very sarcastic reprimand. Yet, for all his over-positiveness and impatience of contradiction, Roosa was a man of most excellent intentions, and a true and loyal friend. A correspondent writes to me, "Whatever else you say in Roosa's sketch, be sure to emphasize his loyalty." Another declares, "Under all his rough exterior, he was one of the finest men I ever knew."

Dr. Roosa married, May 8, 1862, Mary Hoyt Blake, daughter of Mr. Stephen M. Blake, of New York City. He died suddenly and painlessly at his home, 20 East 30th St., Mar. 8, 1908.

Roosa's more important ophthalmologic writings and translations are as follows: 1. *Stellwag on the Eye.* (Trans. with Drs. Hackley and Bull, 1868.) 2. *Ophthalmic and Otic Memoranda.* (In conjunction with Dr. E. T. Ely.) 3. Remarks on Simulated and Hysterical Loss of Sight. (*N. Y. Med. Rec.*, 1874.) 4. On Conjunctivitis. (*Ibid.*, 1878.) 5. On Sympathetic Ophthalmia. (*Ibid.*, 1878.) 6. *An Examination Under Atropine of the Refractive State of Eyes with Normal Vision (20/20.) and Which had Never Been Affected with Asthenopia or Inflammation.* (New York, 1878.) 7. Keratitis; its Relation to the General Condition of the Patient. (*N. Y. Med. Rec.*, 1879.) 8. Lacrymal Catarrh. (*Ibid.*, 1879.) 9. The Cure of Constitutional Diseases by the Use of Glasses. (*N. Y. Med. Rec.*, 1880.) 10. *A Doctor's Suggestions.* (1880.) 11. Traumatic Retinal Hemorrhage. (*Trans. Am. Oph. Soc.*, 1881.) 12. *Handbook of the Anatomy and the Diseases of the Eye and Ear.* (In conjunction with A. Edward Davis, Philadelphia, 1904, p. 297.) We may add, as of interest to oto-ophthalmologists: "*A Practical Treatise on the Diseases of the Ear.*" (1866, 6th ed., 1885. One English and one German edition.)—(T. H. S.)

Roosbroeck, Jules van. A celebrated Franco-Belgian ophthalmologist. Born at Lyons, Jan. 9, 1810, he there received his medical degree in 1833. He then studied ophthalmology under Jueugken at Berlin, and under Friedrich Jaeger in Vienna. In 1838 he was called to Ghent as professor of hygiene and ophthalmology, and in 1853 he was made director of the Ophthalmic Institute. He also became a Fellow of the Academy of Medicine of Belgium. He died July 1, 1869.

Roosbroeck's ophthalmologic writings are as follows: 1. *Coup d'Oeil sur l'Opération de la Pupille Artificielle.* (Lyons, 1841.) 2. *Précis de l'Ophthalmie des Nouveaunés.* (Brussels, 1843.) 3. *Cours d'Ophthalmologie Enseigné à l'université de Gand.* (Ghent, 1853.)—(T. H. S.)

Rosacea keratitis. See **Keratitis rosacea,** p. 6809, Vol. IX of this *Encyclopedia.*

Rosacea keratitis, Neuropathic. Under this caption F. H. Verhoeff (*Archiv. of Ophthal.,* March, 1916) refers chiefly to peripheral corneal lesions accompanying herpes facialis, and which are neuropathic in origin. They are located about 1.5 mm. from the limbus and the author believes that they occur at the termination of the conjunctival nerves in the cornea, and that they are manifestations of the general tendency of herpetic lesions to occur at the periphery of the area of nerve distribution. The author has shown that, histologically, the lesions of superficial punctate keratitis consist of localized infiltrates of necrotic pus-cells situated immediately beneath Bowman's membrane. His method of treatment is to do a partial peritomy, thus preventing abnormal impulses from reaching that portion of the cornea. Healing promptly occurred in fifteen consecutive patients operated on. In twelve of the cases, the corneal lesions failed to stain with fluorescin at the end of forty-eight hours and in the remaining cases they could be stained slightly for a day or two longer.

Rosacea ocularis. A term applied by Uribe-Troncoso (*Archives of Ophthalm.,* p. 1, Vol. 47, 1918) to a fascicular keratitis associated with acne rosacea.

Rosaceous. Rose-red; roseate.

Rosanow's test. This is a test for pretended monocular blindness. Light is reflected with the ophthalmoscopic mirror into both eyes repeatedly and rapidly. The patient does not always know (owing to the intercrossing of the optic fibres at the chiasm) which eye is being illuminated and on being asked is likely to name the blind eye. It is not a very satisfactory test.

Rosas, Anton. A famous Viennese ophthalmologist, author of a textbook now forgotten but very useful in its time. Born at Fünfkirchen, Hungary, Dec. 30, 1791, he studied at Pesth and Vienna, at the latter institution receiving his medical degree in 1814. On this occasion his dissertation was "Diss . . . quae Rejecta Fistulæ Lacrymalis Idea, Veram Fistulæ Sacci Lacrymalis Nationem et Sanandi Methodum, Excepta Occlusi Ductus Nasalis Operatione, Proponit." In 1816 he received the degree of Master of Surgery, and was at once appointed assistant physician in the General Hospital. For a time he was assistant to Beer, and then (1819) became professor of ophthalmology at Padua. In 1821, however, he returned to Vienna in order to accept the chair of ophthalmology. He was ennobled in 1837, and, on the 31st of May, 1855, he died.

He wrote with equal facility in German and in Italian. His oph-

thalmologic compositions are as follows: 1. *Saggio sul Ottalmia che Regnò negli Anni 1822-23 nell, J. R. Regimento ital. N. 13 d'Infanteria Wimpfen.* (Venice, 1824.) 2. *Handbuch der Theoretischen und Practischen Augenheilkunde*, 3 vols. Vienna, 1830. 3. *Lehre von den Augenkrankheiten.* (597 pp., Vienna, 1834.) 4. Ueber den Werth der Staar-Ausziehung im Allgemein und ihrer Verschiedenen Methoden insbesondere, nebst Vorschlägen zur Sicherung des Erfolges derselben. (*Med. Jahrb. d. K. K. Oesterreichischen Staates,* Vol. XXI.) —(T. H. S.)

Rose. In ancient Greco-Roman times the oil, the leaves, and the flowers were all employed in various diseases of the eyes, especially xerophthalmia, psorophthalmia, and acute affections accompanied by profuse discharge. Bread, soaked in rose-oil and wine and bound about the eyes and the forehead, was a remedy held in great esteem, and the leaves alone were often employed as a poultice for any kind of headache.—(T. H. S.)

In modern times the petals of the pale rose (*rosa centifolia*) are those generally used in making *rose water* and in perfuming *cold cream.* See **Unguentum aquæ rosæ.** The flowers of *rosa damascena* afford the oil (attar or ottar) of commerce. The flowers of the red rose *(rosa gallica)* furnish the confection of roses.

Rosemary. *Rosmarinus officinalis.* Rosemary juice, according to Pliny the elder and Dioscorides, is an excellent remedy for the affection vaguely known as "weakness of the sight."—(T. H. S.)

Rosemary, Wild. See **Labrador tea.**

Rosenbach's phenomenon. ROSENBACH'S SIGN. There are two symptoms-complex generally attributed to Rosenbach, (1) the tremor of the upper lid in *exophthalmic goitre*, when the effort is made gently to close the eye, and (2), in *neurasthenia*, when there is inability to close the eyes when the patient stands with his feet close together—as in the Romberg position. See *Journ. Am. Med. Assocn.*, p. 2001, Nov., 1913.

Rosenmüller, Valve of. HUSCHKE'S VALVE. A crescentic fold in the lachrymal duct near its junction with the lachrymal sac.

Roser, Wilhelm. A German ophthalmologist whose observations and investigations related chiefly to staphyloma of the cornea and specific ophthalmia. According to Wernich,* he was born at Marburg; according to Hirschberg, however (who is probably right) he was born at Stuttgart. His father was a well-known entomologist; and his uncle, the poet Ludwig Uhland. He received his medical degree

* Wernich gives the date of his birth and also of his "approbation" as 1817—a rather remarkable instance of precocity.

at Tübingen in 1839. After a number of scientific journeys, he qualified in surgery at Tübingen. About the same time, he founded, in conjunction with Wunderlich and Griesinger, the *Archiv für Physiologische Heilkunde*. In 1844 he published his masterpiece, *"Handbuch der Anatomischen Chirurgie"* (8th ed. in 1884).

In 1851 he was called to the ordinary professorship of surgery at Marburg, where he lectured on ophthalmology, as well as on general surgery.

In the spring of 1888, having reached the age limit, he was obliged to retire, and, on the following Dec. 15, he died of apoplexy.

He was a quick, brusque man, very self-conscious and assertive and self-willed. All who knew him, however, recognized his great ability.

Aside from works of a general character, he wrote the following: 1. *Die Lehre vom Hornhaut-Staphylom.* (Marburg, 1851.) 2. Ueber die Sogenannte Specificität der Ophthalmien. (*Arch. f. Physiol. Heilk.*, 1847.) 3. Thränen-Absorption und Thränen-Fisteln. (*Ibid.*, 1851 and 1857.) 4. Zur Lehre von der Chorioïditis. (*Ibid.*, 1852.) 5. Ueber einige Operationen am Augenlid. (*Ibid.*, 1853.) 6. Ueber Hypopyon-Keratitis. (*Arch. f. Ophth.*, 1856.) 7. Ueber Klappenwirkung bei Sogenannten Glaukom. (*Arch. f. Physiol. Heilk.*, 1859.) 8. Zur Behandlung der Granulösen Augen-Entzündung. (*Ibid.*, 1863.)—(T. H. S.)

Rosette figures. See **Retina, Rosette figures in the.**

Rose water. Water impregnated with oil of roses usually by distillation. It is commonly used as a medium for other ophthalmic remedies, although it is sometimes prescribed alone as a mild astringent and soothing application to the conjunctiva. Rose water is a component of cold cream. See **Rose,** as well as p. 2319, Vol. IV of this *Encyclopedia.*

Rosmini, Giovanni. A well-known Milanese ophthalmologist, founder of the Eye Hospital at Milan. Born in 1832, he was a student of Quaglino's, and, for about four years, his first assistant. In 1859 he became a military physician. He was, however, almost exclusively occupied with ophthalmology. He wrote no book, but a number of practical articles and case reports, and he very materially assisted Quaglino in the introduction into Italy of Graefe's iridectomy for glaucoma. He died at Neroi in March, 1896.—(T. H. S.)

Rosset, Moses John de. A well-known American chemist, physician and ophthalmologist. Born at Pittsboro, North Carolina, July 4, 1838, his early education was received at Diedrich's Academy, Geneva, Switzerland. Returning to America in 1857, he entered the medical department of the University of New York, from which institution he

received his degree in 1859. From then until the outbreak of the War he was resident physician at Bellevue Hospital, but, throughout the Civil War was assistant surgeon in the Confederate Army. At the close of the War he settled in Baltimore, and there became adjunct professor of chemistry in the University of Maryland and full professor of the same subject in the Dental School.

In 1873, however, he removed to North Carolina as ophthalmologist, shortly afterward re-removing to New York. Here he practised as ophthalmologist till shortly before his death. Among his ophthalmologic articles is an excellent one in the *American Journal of the Medical Sciences* entitled "The Muscle of Accommodation and its Mode of Action." Dr. de Rosset died in 1881.—(T. H. S.)

Rosset, Otto. A Polish surgeon, who devoted considerable attention to diseases of the eye. Born at Polock, Mar. 23, 1790, he was for a time a surgeon in the Russian army. His medical degree was conferred in 1849 at Warsaw, his dissertation being "De Usu Lapidis Infernalis in Blepharophthalmia et Illius Sequelis." From 1851 until his death he was a Fellow of the Medical Council for Poland. He died in 1859.

He published a number of ophthalmologic writings in a Polish journal, *Pamictnik Tow. lek. Warszawskiego*.—(T. H. S.)

Ross, Gustav. A well-known physician, brother of the celebrated archeologist, Ludwig Ross. Born near Altkoppel, near Bornhöved, Sept. 29, 1818, he received his medical degree in 1843, presenting as dissertation "De Morbis Brightianis Adnumerandi Specimini Memorabili." For a number of years he served as physician in the German army, and then established at Altona a private infirmary for surgical and ophthalmic patients. In addition to a number of general works, he wrote "*Mittel und Wege des Abflusses der Thränen.*" He died at Altona May 8, 1861.—(T. H. S.)

Rotation, Centres of. See **Muscles, Ocular,** as well as **Center of motion of the eye,** p. 1952, and **Center of rotation,** p. 1953, Vol. III of this *Encyclopedia*.

Myers (*Oph. Year-Book*, p. 58, 1916) made in this connection the following experiment: a blind eye was transfixed with a needle through cornea and lens and vitreous to the posterior pole. Radiographs were then taken with patient looking to right and to left. Then the patient's head was turned on the side and pictures taken with eye looking up and down. The globe was measured after enucleation and compared with the pictures and from these the center of rotation was located 15 mm. back of the cornea and 12 mm. in front of the macula, the globe being 27 mm. on the antero-posterior axis.

Rotation, Plane of. See **Muscles, Ocular.**

Rotations of the eyeball. See **Tropometer**; also 4697, Vol. VI and the figure on p. 1415, Vol. II of this *Encyclopedia*.

Rotatores oculi. (L.) The oblique muscles of the eye.

Rotatory polarization. The change of the plane of polarization of a plane polarized ray to the right or left when passing through certain substances.

Rotary prism. Risley's prism. See p. 4692, Vol. VI of this *Encyclopedia.*

Rothmund, August von. A prominent German ophthalmologist, known throughout the world for his writings on cataract, bullous keratitis, and the artificial pupil. Born at Volkach, Germany, Aug. 1, 1830, the son of Franz Christoph Rothmund, a well-known general surgeon, he received the degree of M. D. at Munich in 1853. He then studied ophthalmology in Berlin under von Graefe, in Prague under Arlt, and in Vienna under Jaeger. From 1854 he taught ophthalmology at the University of Munich until his retirement (in accordance with law) at the age of 70. He died at Munich Oct. 27, 1906.—(T. H. S.)

Rothmund, Franz Christoph von. Father of August von Rothmund and himself a German ophthalmologist. Born Dec. 28, 1801, he received his medical degree in 1823 at Würzburg, and settled as court physician (expert in legal medicine) first at Miltenberg then at Volbach. In 1843 he became professor of surgery and ophthalmology at Munich, a position which he held till 1871, when he was superceded by Nussbaum.—(T. H. S.)

Rothschild ophthalmologic foundation. A Parisian institution for the treatment of diseases of the eye, founded by Baron Adolphe de Rothschild, of Paris, by the terms of his will. Baren Rothschild died Feb. 7, 1900; work began on the building (at the corner of the Rue Manin and the Rue Priestley) in July, 1902; and was not complete till 1905. The architects were Chatenay and Rouyre. There are 62 beds, spacious rooms, operating halls, a reception room, a dispensary, pharmacy, physicians' offices, etc. The Foundation is open to persons of every race and religion afflicted with curable eye-diseases, and unable to pay for treatment.—(T. H. S.) See **Institutions for the blind.** (For illustration see following page.)

Roth's ophthalmoscope. See p. 9009, Vol. XII of this *Encyclopedia.*

Roth's spots. Whitish spots found in the macular region as a part of certain intraocular diseases, especially metastatic retinitis (q. v.).

Rotoin. A glucoside obtained from *scopola japonica*, having a cycloplegic action resembling hyosein. It has been recommended as a substitute for atropia and in the following formula is prescribed for

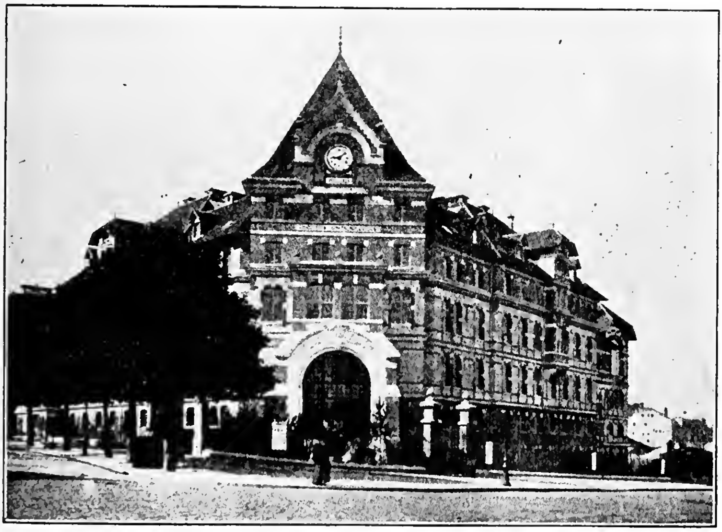
the rupture of posterior synechiæ. It does not irritate the lids even when used for weeks at a time: Rotoin. 0.05 (gr. i); Cocain. hydrochlor. 0.10 (gr. iss); Aquæ dest. 30.00 (fl. ℥i).

Rottura della coroide. (It.) Rupture of the choroid.

Rotzkrankheit. (G.) Glanders.

Rougeole. (F.) Measles.

Rousille de Chamseru. A French physician of the latter half of the 18th century, who wrote a number of ophthalmologic monographs. See **Chamseru.**—(T. H. S.)



Rothschild Ophthalmologic Foundation. (For notice see preceding page.)

Roustan, Félix Marie Gabriel. A celebrated Montpellensian surgeon, who devoted considerable attention to ophthalmology. Born at Mirabel (Drôme) Apr. 30, 1849, he was for a time a surgeon in the army, after which he received his medical degree at Montpellier (1874). His dissertation on this occasion was entitled "Traitement par la Lumière des Maladies des Yeux et en Particulier de l'Héméralopie." In 1875 he was made professor agrégé (associate) in Paris, and two years later removed to Montpellier in order to accept a similar position there. He died early in February, 1885, only 35 years of age.—(T. H. S.)

Roux, Philibert Joseph. A celebrated French surgeon, of moderate importance in ophthalmology. Born April 26, 1780, at Auxerre, the son of a well-known surgeon, he studied medicine at Paris, under the especial tutelage of Bichat, whose prosector and assistant he soon

became. In 1807 he married a daughter of Boyer, and in 1810 became a surgeon at the Charité. In 1820 he was made professor of surgery. About this time he began to devote a great deal of attention to ophthalmology, though his chief activity continued in the general field. He was one of the warmest supporters of cataract extraction, as opposed to depression or reclination. He was an operator of extraordinary skill, but not as great a surgeon as his rival, Dupuytren. Roux died Mar. 23, 1854.

Most of the writings of Roux relate to surgery in general. The following compositions are, however, ophthalmologic in character: 1. Observation d'un Strabisme Divergent, etc. (1814.) 2. Mém. sur l'Opération de la Cataracte par Extraction. (*Jour. Gén. de Méd.*, 1818.) 3. Cours Complet des Maladies des Yeux. (Paris, 1820.) 4. Remarques sur le Strabisme. (*Comptes Rendus de l'Acad. des Sc.*, 1840.)—(T. H. S.)

Rowland, Henry Augustus (1848-1901). American physicist, born at Honesdale, Pa. Appointed in 1874 assistant professor of physics at the Polytechnic Institute, Troy, N. Y., he spent the following year under Helmholtz in Berlin, and while there established experimentally the fundamental principle that a moving electric charge gives rise to a magnetic field. On his return in 1876 he became the first professor of physics in Johns Hopkins University, Baltimore, and held the post until his death. He determined in 1878-1879 the unit of electrical resistance and the mechanical equivalent of heat; constructed in 1881 a dividing-engine for ruling diffraction gratings; and invented in 1882 the concave grating by which spectra can be photographed without the intervention of lenses. By its aid he prepared his great map of the solar spectrum, which, in conjunction with his tables of standard lines and measurements of elemental spectra, placed solar chemistry on a new basis.—*(Standard Encyclopedia.)*

Rowley, William. An English obstetrician and ophthalmologist. Born at London Nov. 18, 1743, he received his medical degree at Oxford, became a naval physician, in which capacity he served for several years, and then returned to London. Here he had a large practice. He died May 17, 1806. His most important writings are: 1. *Essay on Ophthalmia or Inflammation of the Eyes.* (London, 1771.) 2. *A treatise on the 118 Principal Diseases of the Eyes and Eyelids,* etc. (*Ibid.*, 1790.)—T. H. S.)

Royal London Ophthalmic Hospital. Moorfields eye hospital. See **Saunders, John Cunningham** (the founder).

Rubefacients. Counter-irritants. Although but little used in modern

ophthalmic surgery yet these agents are often of considerable value, as in relieving the pain (and perhaps other symptoms) of iritis, keratitis, cyclitis, etc. See, e. g., **Argentum colloidale,** p. 5641, Vol. I of this *Encyclopedia.*

Redness or increased redness is the result of irritation of the skin. Rubefacients cause a slight increase in the capillary exosmosis, and if the irritation be not long continued or too severe the exudate is absorbed and the parts soon return to the normal condition. They all act as counter-irritants.

Iodine, as the tincture or solution, is very effective. Several applications produce blistering or a caustic effect, but this action can easily be controlled. To remove the dark stain from the skin wash the latter with dilute solution of ammonia or a solution of sodium thiosulphate.

Other valuable counterirritants are Credé's ointment, iodopin, jequirity, abrin, jequiritol, turpentine, oil of mustard, alcohol, dionin and peronin.

Rubella. Epidemic roseola. Rötheln. Bastard or German measles. This acute exanthematous febrile disease is not unlike ordinary measles. After an incubation period of from one to three weeks the disease begins with slight fever and catarrhal symptoms, sore throat, pains in the limbs, and the appearance of an eruption of red papules similar to those of measles; but lighter in color, not arranged in crescentic masses, and disappearing without desquamation within a week. Conjunctival hyperemia and other ocular sequelæ, commonly seen in true measles also, are not infrequent.

Rubeola. Morbilli. See **Measles,** p. 7621, Vol. X of this *Encyclopedia.*

Rubidium iodide. Rb I. Colorless, cubical crystals, very soluble in water; a rare and expensive salt. Its internal action is said to resemble that of potassic iodide but with less influence upon the heart. Bunge, in *Merck's Bericht* for 1893, reports its use as a collyrium (5 per cent. watery solution) in parenchymatous keratitis.

Rue. *Ruta graveolens.* In ancient Greco-Roman times this plant was highly esteemed as an ophthalmic remedy. For ocular pain, it was mixed with barley meal and applied to the eyes or the forehead. In "hot" discharges from the eyes it was similarly employed, but mixed with goose-grease instead of barley meal. The juice, mingled with milk and honey, was used for the vague affection known as "weakness of the sight." Pythagoras, however, believed that rue was very injurious to the sight.—(T. H. S.)

Ruete, Christian Georg Theodor. A celebrated German ophthalmologist. Born May 2, 1810, at Scharenbeck, near Bremen, Germany, he

received his medical degree at Göttingen in 1833, and at once became an assistant to Himly. Three years later he became a privatdocent for ophthalmology, and, the year following, resigned his assistantship. In 1841 he became extraordinary, and in 1847 ordinary, professor. In 1852 he removed to Leipsic in order to accept the chair of ophthalmology and the directorship of the Eye Infirmary in that city—a position which he held until his death. From 1853-'61 he was chief of the Medical Polyclinic. He died of apoplexy, June 23, 1867.

Ruete was a genial, joyous-hearted man, clear-headed, and highly esteemed by students and the sick. His patience in scientific investigation was simply inexhaustible, and he was also very inventive. Ophthalmoscopy by means of the inverted image was introduced by him.

His most important writings are as follows: 1. Die Anwendung der Physiologie auf die Augenheilkunde. (Wagners *Handwörterbuch*, 1845.) 2. *Neue Untersuchungen und Erfahrungen über das Schielen und seine Heilung.* (Göttingen, 1841.) 3. *Klinische Beiträge zur Pathologie der Augen und Ohren.* (Braunschweig, 1843.) 4. *Lehrbuch der Ophthalmologie.* (Braunschweig, 1845, '46; 2. Aufl. 1855.) 5. *Ophthalmotrop.* (Göttingen, 1846.) 6. *Der Augenspiegel und das Optometer.* (*Ibid.*, 1852.) 7. *Bildliche Darstellung der Krankheiten des Mensihlichen Auges.* (Leipsic, 1854-'60.) 8. *De Irideremia Congenita ejusque Vi in Facultatem Accommodationis Oculorum.* (*Ibid.*, 1855.) 9. *Explicatio Facti quod Minimæ paulum Lucentes Stellæ tantum Peripheria Retinæ Cerni Possint.* (*Ibid.*, 1859.) 10. *Das Stereoskop.* (*Ibid.*, 1860; 2. Aufl. 1867.) 11. *Commentatio de Visu Insectorum cum Oculis Polyëdricis.* (*Ibid.*, 1861.) 12. *Ueber die Einheit des Princips im Bau der Augen bei den Verschiedenen Thierclassen*, etc. (*Ibid.*, 1861.) 13. *Uebersicht der in den Jahren 1862-'64 in der Augenheilanstalt zu Leipzig Verrichteten Lappenextractionen.* (*Ibid.*, 1867.)—(T. H. S.)

Rufescent. Verging towards a dull-red color.

Rufus of Ephesus. A famous physician of Alexandria, who lived in the time of Trajan, i. e., the early portion of the second century, A. D. His genuine works were: 1. *On the Names of the Parts of the Human Body.* 2. *On Diseases of the Kidneys and Bladder.* 3. *On Purgative Medicines.* 4. *On Arthritis.*

Only the first of these is of special interest to ophthalmologists. As the work in its entirety is not accessible to the present writer, he subjoins herewith a translation which he has made from the extracts (and the German renderings thereof) as presented in his *"History"* by Hirschberg.

"The eyebrows are the hairy (lower) margins of the forehead; the 'interbrow' the space which separates them. Under the brows (follow) the lids, an upper and a lower. Out of these grow forward (from the border) hairs, called 'lashes.'

"The borders, which touch each other during sleep, are called 'wreath' or 'claws.' The space above, on the upper surface of the upper lid is called the 'pit.' The swerving ends of the upper and lower lids form the 'angles'; the larger is that toward the nose; the smaller, that toward the temple.

"The part of the eyeball which is visible to us in the center, is called the 'sight,'or 'maiden.' And 'puppet' is the name for the tiny image in the sight. And all that reaches from the pupil to the white of the eye is the 'rainbow.' This is called, according to its color in the individual, the 'black,' or 'yellow,' or 'blue' of the eye. But a garland-shaped border surrounds the dark of the eye, and separates it from the white. This garland is a regular circle, and the bond (ligament) of the membranes of the eye: of the latter the first possesses a twofold constitution and therefore two names. It is similar to horn on the forward center of the eye and as far as the iris extends. This part of the upper membrane resembles polished plates of horn.

"The remainder of the uppermost membrane is pure white, even as it appears to our view, entirely unlike its previously mentioned middle part, not only in point of constitution but also in that of color.

"There lies, however, superficially upon this white part the so-called 'upper membrane' (bulbar conjunctiva), which on the one hand in small children is lifted up, and, on the other hand, in aged persons and in the disease called 'chemosis.' In the latter affection it appears as a reddish elevation. How the remaining membranes are called will soon be told under 'The Dissection of the Animal.'

"Of the membranes of the eye, the uppermost has been already designated as the 'keratoid,' in the explanation of the superficial parts. Of the others the second is called the 'rhagoides' and 'choroides.' And indeed the part which lies beneath the keratoides proper is called 'rhagoides' because it resembles a grape by the smoothness of its outer, and the roughness of its inner, surface. But the part which lies beneath the white portion of the first membrane is called 'choroides,' because it is rich in vessels, and therefore looks like the choroid coat which surrounds the embryo (fetus). The third membrane of the eye encloses the glass-like humor, and is called by its old name, 'arachnoides' (= spider's web) on account of its thinness. However, inasmuch as Herophilus compares it to an outspread fishing-

net, a few physicians call it also the anphiblestroeides (the fishing-net-like membrane); others, however, the hyaloid (crystalline) membrane, from the humor which it encloses. A fourth membrane surrounds the crystalline humor; this formerly had no name, but was later called the phacoides (lens membrane) from its form, and also, from the humor which it encloses, the crystalloeides (crystalline membrane)."—(T. H. S.)

Ruggieri, Cesare. A famous Italian surgeon, of slight importance in ophthalmology. Born at Crema, Italy, in 1768, he studied at Pavia, visited France and London, and, returning to his native country, settled at Padua. For a time he was police-physician. In 1803 he became instructor at the Medical School for Marine Surgeons, and twelve years later full professor of surgery at the University of Padua. He seems to have written nothing on the eye, but was widely known as an ophthalmic operator, and from 1817 to 1819 was chief of the clinic at Padua. Perhaps his greatest achievement was the "*Dizionario Enciclopedico di Chirurgia, traduz. dal Francese, accresciuto di aggiunte e note pratiche* (6 vols., Padua, 1805-'09). Ruggieri died Feb. 13, 1828, aged 60.—(T. H. S.)

Ruhelage. (G.) Position of rest.

Rumble's test. For color blindness; see p. 2456, Vol. IV of this *Encyclopedia.*

Rumford's photometer. In addition to the matter on p. 9701, Vol. XIII, on p. 5226, Vol. VII and elsewhere in this *Encyclopedia* it may be said here that in the Rumford device advantage is taken of the comparison of two lights by observing the relative distances at which they produce equal illumination; also the depth of shade of two shadows of the same object cast by the lights.

Rupert's drops. Drops of molten glass suddenly cooled by being dropped into cold water.

Rupture. For a review of most forms of rupture of ocular tissues the reader is referred, in addition to the several captions to follow, to **Injuries of the eye,** p. 6200, Vol. VIII of this *Encyclopedia.*

Rupture of Schlemm's canal. See p. 6260, Vol. VIII of this *Encyclopedia.*

Rupture of the choroid. See **Choroid, Rupture of the,** p. 2165, Vol. III of this *Encyclopedia.*

Rupture of the cornea. See p. 3442, Vol. V of this *Encyclopedia.* Bishop Harman (*Proc. Roy. Soc. Med., Sec. Ophthalm.*, March, 1915) reports this accident in a man affected with congenital sub-luxation of each crystalline lens. One eye became red and painful after a fall upon the corresponding temporal region, and when seen some eight

months after the accident, the eye was found to be in a condition of glaucoma. Some three years later, without known cause, the man appeared with a rupture in the lower part of the cornea, through which the membranes protruded from the eye. Section of the eye showed that an expulsive retrochoroidal hemorrhage was present which had driven the membranes forward, so that the last-named were stretched between the optic disc and the cornea and hung out from the rupture. Harman thinks that ulceration or degeneration of the cornea must have taken place to render the event possible.

Rupture of the ciliary arteries. In addition to the indirect reference to this little known form of traumatism on p. 6330, Vol. VIII of this *Encyclopedia*, Marie Hugenin (*Clinique ophtalm.*, Feb., 1916; abstract by Ernest Thomson in the *Br. Journ. of Ophthalm.*, p. 991, Feb., 1917) says that Siegrist, of Berne, in 1895 gave the first description of traumatic rupture of the ciliary arteries and consecutive fundus alterations. He published four observations. Two cases have since been described by Birkhauser and three by Hirsch. Thus, with the two here described by Huguenin, eleven cases altogether are comprised.

These 11 cases have a similar etiology. In all of them we have to do with a traumatism by a blunt object (stone, wood), not, as a rule, causing any laceration of the tissues, but merely contusion or slight excoriation. As a matter of fact, in 6 of the cases there was no wound at all, merely ecchymosis and swelling. In one case there was a small excoriation of the skin of the eyelids, while 4 cases only presented more or less severe wounds of the eyelids. The eyeball thus suffered very little externally. In all the cases there was ocular injection, usually of a mixed type, but very moderate in character and usually disappearing in a few days. In a few cases excoriations of the corneal epithelium occurred. Tear of the iris was seen in 2 cases and in 2 the iris was tremulous. In most cases the wounding object came from some distance away, and the trauma was of the upper lid.

In almost all the cases the pupil of the injured side was wide and motionless. In one case it was contracted. Pupil dilatation and immobility persisted for a long time, and sometimes did not completely disappear. In some cases there was blood in the anterior chamber, in the vitreous, and also discoloration of the iris. Pain had never been a pronounced feature, nor did it last long. The visual defect is immediate. In each case the patient, almost immediately after the injury, noticed pronounced diminution of vision in the injured eye. As a rule, the patient did not seek advice until some time after the accident, because at the beginning he or she did not realize the im-

portance of the visual loss, and was impressed only by its long duration.

In the ten cases in which ophthalmoscopic examination was possible, the fundus lesions were identical, with small peculiarities in each individual case. The rapid appearance after the injury of irregular, map-like decolorized patches, with sharply-defined contours, situated in the neighborhood of the disc and usually starting from the edge of the latter, has been a feature in each one of these cases. In every case, as time went on, there occurred a blackish pigmentation of the decolorized patches. At the beginning the pigment appeared in the form of fine grains, but after some time, it became heaped up into more or less pronounced groupings, with a tendency to migrate towards the edges of the patch. Choroidal tear was seen in one case.

In two cases there was a hemorrhage in the macula region, and in four cases striations in the form of a demi-corona around the macula. In one case only there was a hole in the macula, and on this occasion the decolorized patch did not start from the papilla, but surrounded the macula.

In most cases there was no improvement in the vision with time. It remained stationery, or even in some cases deteriorated.

If the short posterior ciliary arteries are divided, the patch of fundus concerned starts from the superior or inferior border of the disc and extends towards the periphery. This is what happened in Wagemann's experiments on the rabbit.

In eight cases the altered patch started from the lateral edge of the disc. In one of Birkhauser's cases the affected portion was at the superior disc edge.

According to Siegrist, one cannot deny that causes other than laceration of a ciliary artery may produce the ophthalmoscopic appearances above described, as, for instance, a choroidal or sub-choroidal hemorrhage resulting from lesions of the choroidal vessels. Such hemorrhages naturally influence the choroidal circulation and may produce secondary degeneration in the outer layers of the retina. Sudden flattening of the globe from before backwards by a blow from a blunt object may bring about these choroidal hemorrhages. At any rate, the specific affection under consideration is due to circulatory trouble of the choroid.

Rupture of the eyball. See pp. 6206, and 6255, Vol. VIII of this *Encyclopedia*.

E. C. Ellett (*Journ. Am. Med. Assocn.*, p. 200, July 16, 1910) describes a case of *spontaneous rupture of the eyeball in glaucoma.* Search of the literature reveals twenty-two cases, one reported in 1879 (Cheatham), one in 1881 (Vergely), and the others since 1899.

The patients, with one exception (Hauenschild), were old people, aged from 56 to 89. Indeed, with the single exception of Zimmermann's patient, aged 56, none were less than 63. The writer further points out that Hauenschild's case is evidently in a different category from all the others, and, excluding this case, the patients were all the subjects of chronic glaucoma. In many of them this was established before the rupture of the eye; in others the subsequent examination or previous history makes the presumption of glaucoma plainly justifiable. The hemorrhage in all cases proceeded from the vessels of the choroid, and the rupture of the ball occurred in the cornea. In nearly all of the cases these phenomena were spontaneous, there being usually no apparent cause, such as trauma or straining. We might profitably consider this condition, since the number of cases reported indicate that it is not so rare as not to be of general interest, and inquire how it happens, when and why it may happen, and what is our duty in case it does happen.

In inquiring how spontaneous rupture of a glaucomatous eye comes about, we find a difference of opinion among those who have observed it. Some assert that the rupture of the cornea is primary, and due to the perforation of an ulcer, or the traumatic rupture of an ulcerated or otherwise weakened cornea, the resulting lowered tension permitting the unsupported intra-ocular vessels to break, with resulting hemorrhage. Others contend that the intra-ocular hemorrhage is primary, and that the increased tension causes rupture of the cornea, which may or may not have been previously weakened by disease.

Whichever view we consider, it can be justified by analogy, which is well, since in a given case one cannot always be sure of the sequence of events. In favor of the idea that the rupture of the cornea is primary and the hemorrhage secondary, the occurrence of choroidal hemorrhage during a cataract extraction could be cited. Here we see the rupture of the choroidal vessels occur when the cornea incision and evacuation of aqueous has lowered the pressure which supports the vessels. In support of the other theory, that the hemorrhage is the primary event, the occurrence of cerebral hemorrhage might be regarded as analogous. With or without apparent exciting cause, but presumably accompanying an increase of blood-pressure from some cause, the diseased vessel breaks. The question now arises whether a hemorrhage from the choroidal vessels can increase the intra-ocular pressure to such a point that rupture of the cornea will follow. Among those who have reported cases a difference of opinion is found. Villard, Verhoeff and Spalding, Valude (discussing Terson's cases), Gamo Pinto, Bialetti and Lissigyn, have expressed themselves more

or less emphatically to the effect that the sequence of events is, first, the rupture of an ulcerated cornea, and then the hemorrhage. Verhoeff and Spalding, in particular, question the possibility of a hemorrhage raising the pressure enough to rupture the cornea, since the intra-ocular pressure is already as great as, and dependent on, the blood-pressure. A rupture of an intra-ocular vessel, then, does not, according to these observers, increase the intra-ocular tension. On the contrary, Wibo, Gilfillan, Millikin, Fage and Ingalls think that the hemorrhage preceded, and presumably caused, the rupture in the cases they observed. In Shepherd's case and in that of the writer the cornea was normal.

In cases not observed before rupture it may be hard to tell, since all of the ulcerated corneal tissue may be torn away by the passage of the blood and membranes through the rent.

The occurrence of this distressing accident is predicated on the existence of several conditions. A study of the reported cases would justify one in saying that these conditions are glaucoma, vascular disease and probably an ulcerated or otherwise weakened cornea.

Glaucoma, on theoretical grounds, would not appear essential to the occurrence of this accident, but, in fact, it is present with too great regularity to be regarded as a coincidence. The vascular changes, with increased blood-pressure, necessary to produce the condition in question, seem always to produce glaucoma, a fact easily understood in the light of the now general appreciation of the close relation between glaucoma and vascular disease.

Lacompte (*Oph. Year-Book*, p. 276, 1913) gives the history of an unusual case of rupture of the eyeball. In a 65-year-old woman there occurred a spontaneous hemorrhage and rupture of the eyeball, accompanied by severe vomiting. The eye was immediately enucleated without any excessive bleeding. Glaucoma was found to be present and the author regarded the case as one of retinal apoplexy, preceding an acute attack of glaucoma.

Rupture of the optic nerve. See p. 6338, Vol. VIII of this *Encyclopedia*.

Rupture of the retina. See p. 6337, Vol. VIII of this *Encyclopedia*.

Rupture of the sclera. See p. 6262, Vol. VIII of this *Encyclopedia*.

Russ. An American to whom we are indebted for a modification (in 1870) of the Braille system, known as New York point print. See **Alphabets for the blind.**

Russel's bodies tumor. The formations are described by Komoto (*Klin. Monatsbl. f. Augenheilk.*, July, 1914) in a hitherto undescribed tumor of the conjunctiva. A flat, lobulated, grayish, firm tumor of the retrotarsal fold of the conjunctiva, made up almost entirely of intra- and

extracellularly placed globules of various sizes. The arrangement is mulberry-like and the cells acidophilic. Komoto describes Russel's bodies as follows: Strongly refractive, round, clear-cut globules of hyalin material which stain strongly with anilin dyes and which are of from staphylococcus to plasma cell size. They are partly intra-, partly extracellular, and are arranged in mulberry or grape-like masses. The tumor resembles the picture of pseudotuberculosis, and is probably the result of irritation from a foreign body. Entire fields were full of the Russel bodies, which prompts Komoto to call the growth by that name.

The bodies develop from or in the plasma cells, and as the epithelioid cells arise from the plasma cells, these may also contain Russel's bodies. Russel's bodies are differentiated from all other products of hyalin degeneration because of their marked affinity for picric acid in staining by von Gieson's method. These bodies are colored dark-brown with medullary sheath staining methods. They develop within a period of one hundred and fifty-three days.

Rust, Johann Nepomuk. A well-known German official physician, surgeon and ophthalomologist. Born at Castle Johannisberg, at Jauernig, in Austrian Silesia, Apr. 5, 1775, he joined in early life the Imperial Royal Engineer Corps, then studied law at Vienna. Acquiring for the law, however, a very strong distaste, he began to study medicine at Vienna, but, soon migrating, received his medical degree at Prague in 1799. In 1800 he also received the degree of Doctor of Surgery. He began to practise in his native city, but, in 1802, was appointed professor of anatomy, surgery, and obstetrics at the Lyceum in Olmütz, and the following year to the chair of theoretical and practical surgery in Cracow. To become a physician at Cracow he was under the necessity of taking the Russian degree (Med. Doc.), and this he did in 1808. While in Cracow he held many medico-official positions under the Russian Government, and also there erected a Chirurgico-Clinical Institute. He later removed to Lemberg, then to Vienna. In the last named city, he met with so many and such serious disappointments, that, in 1815, he accepted a call to Prussia, where he became General-Division Physician. The following year he was appointed full professor of surgery in ophthalmology at the Medico-Chirurgical Military Academy. After a number of other high positions, he was made, in 1821, Higher Privy Councillor in Medicine; in 1822, General Staff-Physician; and, also in 1822, full professor at the University.

In ophthalmology he seems to have been an excellent instructor but a poor operator. Late in life, having developed double cataract, he

continued to lecture, while Dieffenbach performed his operations for him. Stromeyer (quoted from Hirschberg) holds the following language concerning him: "He was a small, thick man, very myopic, whose right hand was really as innocent of skill as was his left. We were all delighted when his assistant emerged from one of his operations without a wound. He was, however, an excellent teacher."

Rust died Oct. 9, 1840, at Frankinstein, in Silesia.

His only important ophthalmologic writings are: 1. *Theoret.-Prakt. Handbuch der Chirurgie, mit Einschluss der Syphilitischen und Augenkrankheiten.* (17 vols., Berlin, 1830-'36.) 2. *Die Ægyptische Augenentzündung unter der K. Preuss. Besatzung in Mainz.* (Berlin, 1820.)—(T. H. S.)

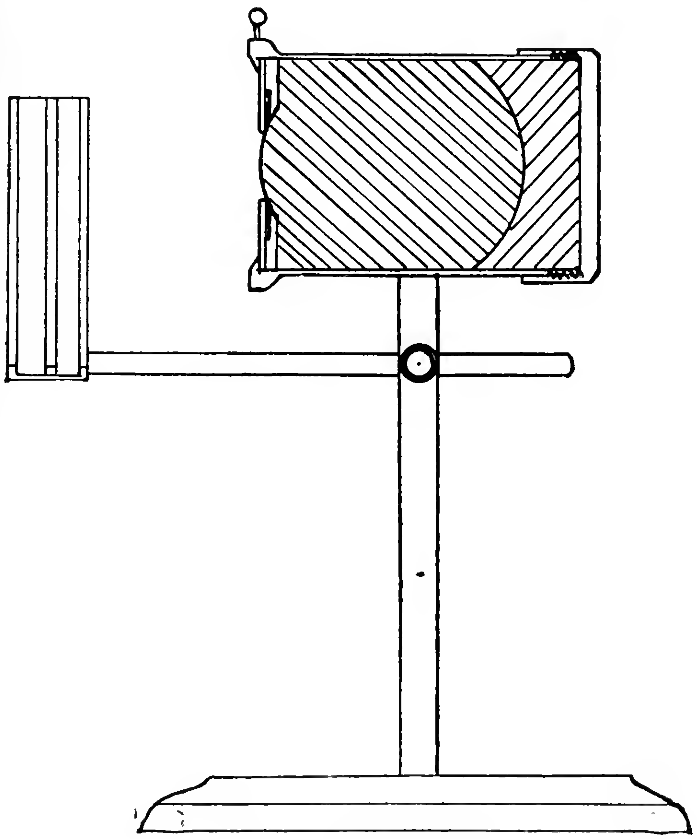
Ruysch, Fredrik. A celebrated Dutch apothecary and physician, who was first to describe the arteria centralis retinæ, the tunica Ruyschiana, the venæ vorticosæ, and the ciliary nerves. Born at the Hague in 1638, he there became an apothecary in 1661, and received his medical degree at Leyden in 1664. He was made prelector of anatomy to the Surgeon's Guild at Amsterdam in 1666, and, in 1672, prelector to midwives. He was afterwards appointed professor of legal medicine and of botany at the Athenæum. He was one of the first (and certainly the best) to practice the injection of vessels in anatomical specimens. By Baas he is called "the inventor of minute injections." He made a remarkable collection of anatomical specimens, including a number of eyes and eye-tissues, which he sold to Peter the Great in 1717 for 30,000 florins. Only a part of the collection, however, arrived in the Russian capital, for the sailors on the vessel which carried the collection, having somehow (perhaps instinctively) learned of the character of the fluid employed in the preservation of the specimens, drank the most of it. Our patient Dutch professor, however, set to work with characteristic placidity to form another collection which he succeeded in doing at the end of ten years. Ruysch also discovered the valves in the lymph-vessels, the bronchial arteries, and pointed out the differences between the male and the female skeleton. He died in 1731.—(T. H. S.)

Ruysch, Membrane of. CHORIO-CAPILLARIS. The network of capillaries spread over the non-pigmented, inner portion of the choroid. See Vol. II, p. 1388 of this *Encyclopedia.*

Ryba, Joseph Ernst. A Bohemian surgeon and ophthalmologist. Born at Rozmintal, Bohemia, Mar. 21, 1795, he received his medical degree in 1829 at Prague. Here he settled, and, for a number of years, was professor of ophthalmology at the University. He was a slow, but very successful, operator. He died Mar. 1, 1856. Ryba's chief ophthal-

mologic writings are: 1. Beschreibung Zweier Fälle von Behaarten Muttermälern der Hornhaut. (v. Ammon's *Zeitschr. f. Ophthalm.*) 2. Ueber den Ausserlichen Gebrauch der Karlsbader Thermaldämpfe und des Karlsbader Säuerlings in Augenkrankheiten. (De Carro's *Almanach de Carlsbad.*) 3. Ueber Theorie und Anwendung des Augenspiegels. 4. Fälle von Symblepharon.—(T. H. S.)

Rye, Spurred. See **Ergot,** p. 4506, Vol. VI of this *Encyclopedia.*



The Ryland Schematic Eye.

Ryland schematic eye. In the Ryland eye four different refractive conditions are possible by means of four solid glass parts made to insert into the eye, as shown sectionally in the cut.

These dioptric conditions are myopia, hypermetropia and emmetropia. The refractive index of the glass is chosen to approximate

the principal and nodal points to their correct positions. In the case of astigmatism the difference is obtained by the use of a toric cornea.

In each case the refractive condition is obtained in the same way that it occurs in the human eye. The back of the globe is left slightly frosted because it gives a realistic appearance to the artificial retina and it facilitates the study of the variation in size of the retinal image for a variation in the lateral position of the correcting lens.

It stands on a solid base, has grooves for correcting lenses and an iris diaphragm for variations in the pupillary aperture. The globes are inserted into the tube from the back and the artificial retina, with clear representation of the fundus, curved to fit on to the eye, is next

Ryland Schematic Eye.

inserted. The addition of the screw cap at back makes an immovable structure of the tube, producing a reproduction of the refractive conditions of the eye. An iris diaphragm in contact with the cornea provides for various pupillary diameters, while by not closing the retinal end of the stand tube, the images of objects formed on the retinal surface of the globe can be observed. This schematic eye is available for the demonstration and study, under conditions closely approaching those of the human eye, of ophthalmoscopy, keratometry, retinoscopy, and ophthalmometry, also changes in the size and definition of the retinal image during examination may be observed.

S. An abbreviation for Latin *semis,* half; *signa,* mark, and *sinister,* left; also the symbol of *sulphur.*

Sabatier, Raphael-Bienvenu L. A celebrated surgeon of Paris, whose work, entitled "*De la Médecine Opératoire*" (Paris, 1796, 1810, 1821, 1824) was highly valued in its day for its full and clear account of the most important ophthalmic operations. Sabatier was born at Paris, Oct. 11, 1732, studied under Petit and Verdier, and became both a Fellow of the College of St. Côme and of the Royal Academy of Surgeons in 1752. He became a celebrated anatomist, as well as surgeon, and wrote in addition to the treatise named above, "*De Bronchotomia, Thèses Anatomica et Chirurgica*" (1752); and "*Traité d'Anatomie*" (3 vols., Paris, 1775; 1781). He died July 19, 1811.—(T. H. S.)

Saccharimeter. SACCHAROMETER. A polarimeter for the optical estimation of the strength of sugar solutions.

Saccharomyces albicans. See **Oidium albicans,** p. 8475, Vol. XI of this *Encyclopedia.*

Saccharomycosis hominis. See **Blastomycetic dermatitis,** p. 1008, Vol. II of this *Encyclopedia.*

Saccharose. See **Sugar.**

Sac, Conjunctival. See p. 354, Vol. I and p. 3039, Vol. IV of this *Encyclopedia.*

Sacculus lacrimalis. The lachrymal sac; a dilatation at the upper end of the lachrymal duct.

Sachs, Abraham. An eye, ear, nose and throat specialist of San Antonio, Texas. Born in Austria, Mar. 1, 1872, he received his medical degree at the Miami Medical College, Cincinnati, in 1900. At first he practised in Cincinnati, then in Chicago, but at length, in 1906, removed to San Antonio. He was a brother of Harry Millard Sachs, a noted actor. He was asphyxiated at his residence on the evening of Jan. 19, 1919, by gas fumes in his bath-room.—(T. H. S.)

Sachs, Albert. A Berlin surgeon and ophthalmologist. Born at Berlin, Aug. 29, 1803, he there received his medical degree in 1825. For a number of years he practised, or attempted to practise, in Berlin, but died of phthisis Nov. 11, 1835, only 32 years of age.

Sachs's ophthalmologic articles were as follows: 1. Neues Ophthalmophantom. (*Hufeland's Jour.*, 1827.) 2. Augenentzüngdung bei Erschütterung des Schädels und Verletzung der Hirnhäute ist ein Zeichen des Nahen Todes. (*Ibid.*, 1828.)—(T. H. S.)

Sachs' disease. See **Tay-Sachs' disease.**

Sachs' lamp. SACHS TRANSILLUMINATOR. See p. 3940, Vol. V of this *Encyclopedia.*

Sachs operation. When the pupillary area is covered totally or nearly so by a corneal or corneo-scleral scar a temporary resection of the cicatrix is done with the aid of a trephine, a method first recommended

by Sachs. With the trephine placed obliquely on the cornea a flap is cut out, which is then lifted by an assistant to enable the operator to enter the anterior chamber, draw out the iris carefully on all sides and cut it off. In order to succeed, the base of the flap must be so situated that the iris can be most easily grasped, this is usually toward the pupil. The iris having been freed, the corneal flap is returned to its position and the eye bandaged. Care must be taken not to injure the lens, when it is not already cataractous. If the lens capsule is adherent to the scar an injury cannot be avoided.

Sachs, Th. A well-known Swiss ophthalmologist, who was privat-docent at Innsbruck. He died in 1897. His most important writing was "Anatomical and Clinical Contributions to the knowledge of Central Scotoma in Affections of the Optic Nerve."—(T. H. S.)

Sac, Lachrymal. The dilated upper portion of the lachrymal duct. See p. 6922, Vol. IX of this *Encyclopedia.*

Saddle-bridge eyeglass. See **Eyeglasses and spectacles, Mechanical adjustment of,** p. 4954, Vol. VII of this *Encyclopedia.*

Sadid b. Raqiqa. A Syrian oculist (1168-1237), friend of the famous Usaibia and one of the official ocular surgeons to the Bagdad Hospital.

Usaibia has the following to say concerning him: "He possessed at the same time knowledge of ophthalmology and of the treatment of wounds, and devised many of the methods of treatment with the iron for the cure of diseases of the eye, and also operated on immense numbers of cataracts, and his operations were successful, and every person saw again, and the needle which he employed was hollow and presented a curve which rendered possible the sucking-out of the cataract at the time of the operation, which made the healing more successful." It is to be remembered that the process of extracting cataract, in the modern sense of the term, was not discovered till the 18th century.

Sadid b. Raqiqa wrote a kind of medical treatise in verse.—T. H. S.

Sadili. See **As-Sadili.**

Saemisch's catarrh. Vernal conjunctivitis.

Saemisch, Edwin Theodor. A famous German ophthalmologist, renowned for his investigations into diseases of the conjunctiva, sclera, and cornea, and one of the founders of the famous Græfe-Sæmisch *Handbuch der Gesammten Augenheilkunde.* Born at Luckau, Nieder Lausitz, Sept. 30, 1833, he studied at Würzburg and Berlin, at the latter institution receiving the degree of M. D. in 1858. He then studied ophthalmology for more than a year under Albrecht von Graefe. From 1860 till '62, he was assistant to Alexander Pagenstecher at Wiesbaden, with whom he published the "*Klinische Beo-*

bachtungen," mentioned *infra*. In 1862 he settled as ophthalmologist at Bonn, where he remained until his death. In 1867 he became extraordinary, in 1873 ordinary, professor of ophthalmology and director of the University Eye Clinic. He was a great operator, teacher, investigator, author and editor. In 1907, at the age of 74, he resigned his professorship. He died Nov. 29, 1909.

His most important ophthalmologic writings are: 1. *Klinische Beobachtungen aus der Augenheilanstalt in Wiesbaden.* With Pagenstecher, 2 Hefte, Wiesbaden 1861 till '62.) 2. *Beiträge zur Normalen und Pathologischen Anatomie des Auges.* (Leipsic, 1862.) 3. *Das Ulcus Corneæ Serpens.* (Bonn, 1870.)—T. H. S.

Saemisch incision. GUTHRIE'S OPERATION. SAEMISCH SECTION. SAEMISCH OPERATION. KERATOTOMY. An incision (made with a Beer's knife or a cataract knife) through the cornea for the evacuation of a hypopyon, relief of tension, etc., in purulent ulcer of the cornea. See p. 3454, Vol. V; and in particular p. 6838, Vol. IX, of this *Encyclopedia.*

Safety goggles. AVIATOR'S GOGGLES. Although this subject has been discussed on p. 1093, Vol. XIII, and under **Conservation of vision,** p. 3235, Vol. V, also under **Hygiene of the eye,** of this *Encyclopedia,* a special form of ocular protection may be, in addition, mentioned here. This is the invention. (*Pop. Mechanics Mag.*, Jan., 1919) of a distinctly new type of safety goggle that possesses remarkable qualities of great advantage to airmen.

One of the outstanding features is that each of the two lenses is formed of one optically plane piece of glass which has no distorting or prismatic effect. Furthermore the position of the lenses and their shape give a visual angle of 170°. These two points are of inestimable value to a flier, especially when landing and in scouting.

Each lens is backed by a transparent shield made of a secret material that has great strength and resilience. The former is only .081 in. thick and the latter .021 in. Between the two is an air space. Here lies the spectacular phase of the invention. While the goggle is being worn, either of the lenses may be struck a heavy blow with a wrench or cold chisel. The lens may be shattered, but the inner shield not only prevents the particles of glass from reaching the eye, but in rebounding hurls them outward and also stops the progress of the instrument. In this connection it is interesting to note that the shield has a tensile strength of from 8,000 to 12,000 lb. to the square inch. The air space between the lens and the shield prevents clouding of the glass at high altitudes.

The lenses are mounted in angular positions in holders and made fast by spring locks similar in principle to those used on motor-car

wheels. This arrangement makes the goggle streamline, so that air resistance is reduced and rain drops are prevented from accumulating on the outer surface. Ventilation is obtained through adjustable openings provided at the top and bottom of each eye compartment. The air enters in such a manner that no direct current can strike either of the eyes. Furthermore, the edges of the goggle are beveled, shaped to fit the face, and trimmed with fur so that air cannot enter except through the ports.

Shocks and jolts received in landing frequently throw a pilot against the cowl of his machine and on many occasions have resulted thereby in broken goggles. For this and other apparent reasons, ordinary goggles are dangerous.

Other nonbreakable goggle lenses, consisting of alternative layers of glass, cement, and celluloid, have been made. Obviously, however, such a combination not only keeps out much light, but may have a distorting effect. The value of the new goggles therefore must be patent even to a layman.

Saffron. *Crocus sativus.* Saffron salve was often employed, in ancient Greco-Roman times, as a remedy for incipient cataract, and the leaves were used as a poultice for any sort or kind of painful ocular affection. "Crocomagma," which consisted of the residue left after the preparation of saffron oil, was especially in favor as a means of removing cicatrices from the cornea, while "perichrista," a compound preparation whose chief ingredient was saffron, enjoyed an equal reputation for ophthalmia neonatorum.—T. H. S.

See, also, **Crocus,** p. 3567, Vol. V of this *Encyclopedia.*

Safranin. See **Labratory technic.**

Sagapenum. A foul-smelling gum, obtained from a species of *ferula.* It was much employed in the times of Celsus and Dioscorides as a remedy for various affections of the eye, especially cataract.—(T. H. S.)

Sage. A genus of Labiatæ, containing many species, herbaceous and half-shrubbery. Common sage, or garden sage (*salvia officinalis*) so much grown in gardens as an aromatic herb for flavoring purposes in cookery, is a native of Europe and was a popular remedy in ancient times for ulcers and scars of the cornea. It is possessed of active properties, as its powerfully aromatic odor and bitter taste indicate. The leaves and flowering parts of the plant, infused as tea, are considered tonic and astringent. The plant contains an essential oil of sage, which has been used in liniments against rheumatism. Clary is a species of sage.

Sago-grain masses. The collection of trachomatous follicles whose appearance gives rise to the name. See **Trachoma.**

Sailors, Examination of the eyes of. See **Eyes of soldiers, sailors, railway and other employees, Examination of the.**

Visual requirements of the United States Navy. This interesting subject is fully treated by Passed Assistant Surgeon W. E. Carson (*Jour. Amer. Med. Ass'n.*, July 27, 1918). He directs attention to the fact that the visual requirements of the Navy are in general more stringent than those of the Army. At the same time they are simpler and more definite, both because of the much narrower latitude allowed for correction by glasses and because they are more categorical.

The visual requirements of the United States Navy may be said to be more severe than those of other countries having large navies, since conditions governing the physical requirements in the larger foreign navies are necessarily different from our own. In only one, that is in the British navy, does the system of voluntary enlistment prevail. In others, the recruits are subjects of a universal draft system, the seafaring districts furnishing conscripts so far as needed for the navy, recruits from other districts going to the army.

For a proper appreciation of the visual requirements of the various ratings, it is necessary to have clearly in mind the different branches of the service and the duties involved therein. The enlisted men of the Regular Navy and of the Reserves, for the most part included under the United States Naval Reserve Force, may be classified in three main branches: (1) the seaman branch, which includes those directly responsible for navigating the ship and manning the guns; (2) the artificer branch, such as machinists, electricians, carpenters, plumbers, blacksmiths and firemen, and (3) the special service branch, which includes the yeoman or clerical service, hospital corps, musicians and cooks, also those rated in the radio service and aviation service besides the Marine Corps.

Commissioned officers, both regulars and reserves, are divided into officers of the line or those in charge of matters of navigation, executive command and similar duties and officers of the staff including medical officers, constructors, civil engineers, the pay corps and chaplains.

It is well to recall also the expansive effect on the personnel of the Navy of the present war, significant of which is the fact that any tendency to lower the standard of visual and other physical requirements is naturally to be traced to expanding the forces more rapidly than volunteers measuring up to full standard requirements can be obtained.

The declaration of war, April 6, 1917, found us with a total enlisted strength of 65,000 in the Navy, or including the Marine Corps,

82,738. We now have approximately 400,000 officers and men in the various branches of the Navy, all volunteers.

Notwithstanding the fact that the complement of the Navy has been increased to five times its original number and that still greater expansion is anticipated in the immediate future, no relaxation in the standard of visual requirements of the Regular Navy has been ordered and at present no such relaxation is contemplated. The same is true of the Reserves except for a certain class of men enlisted for shore duty to be noted later.

The visual requirements of the Regular Navy and Marine Corps may be thus summarized (unless otherwise stated, all vision values are without correction with glasses): Recruits for enlistment in the Navy including the Marine Corps are required to have normal vision, or 20/20 for each eye, but in candidates who are otherwise physically sound a minimum visual acuteness of 15/20 will suffice. Color vision must be normal. Various abnormal conditions are given as causes for rejection, such as trachoma, pterygium, strabismus and others which need not be fully enumerated here.

Candidates for admission to the United States Naval Academy are required to have 20/20 vision in each eye, without the aid of glasses, and the regulation states that there shall be no deviation from this rule.

For the Medical Corps, Dental Corps, civil engineers and for chaplains there must not be less than 12/20 for each eye, unaided by glasses and capable of correction by glasses to 20/20. The eyes must be free from disease and color vision normal. For line officers and the pay corps, there must not be less than 15/20 for each eye, unaided by glasses and capable of correction by glasses to 20/20. For officers of the Marine Corps, 18/20 for each eye, unaided by glasses and capable of correction by glasses to 20/20. Normal color vision is required. The foregoing applies to regular and, in general, to reserve officers.

In the case of officers for promotion, the vision, hearing and other functions must be such as, in the opinion of the board, will enable such officers to perform efficiently their duties at sea.

In the Navy Nurse Corps (female), no specific requirements are observed beyond what is necessary in the opinion of the examining surgeon for proper performance of the work required, the same being subject to approval by the department.

In individual cases, in which the candidate may fall slightly below the standard required by the regulations, and where, in the opinion of the medical recruiting officer, he presents unusual qualifications

otherwise, a request for a waiver of the defect may be submitted to the department which will assume the responsibility of the decision in such cases.

In addition to the foregoing, there are certain exceptional requirements for special duties specified, some of which are more liberal, others more rigid, than the usual requirements. Under the more liberal requirements, it may be noted that applicants for service in the Naval Reserve Force who would otherwise be ineligible for enlistment may be accepted for special duty in Class 4, for service which involves shore duty only. Here the visual requirement is that which, in the opinion of the examiner, is required in any given case for the applicant properly to perform the duties of the position or rating to which he is to be assigned. Thus it is possible during the emergency to enlist for temporary service large numbers for duty at naval stations, navy yards and elsewhere for shore duty as barbers, cooks, tailors, shoemakers and for similar occupations, in this way releasing a corresponding number of more standard men for sea duty. Except as noted, the visual requirements for Reserves are the same as for Regulars. In the entire seaman branch, the requirements are the same.

Examples of special duties, in which there are more rigid requirements, are those of aviators and gun pointers already enlisted, who must pass special examinations to be eligible for these duties.

The visual requirements for aviators, which are the same as those for aviators in the Army, namely, 20/20 in each eye, with eyes otherwise normal, need not be further discussed here.

For gun pointers, the visual requirements are more severe than for any other class of duty, and the regulation which has been in force since 1908 requires that the candidate for such rating shall have 20/15 vision in the right or aiming eye and at least 20/20 in the other eye. A test of the visual acuity of qualified pointers is made before each target practice and the result entered on the record, a report being also sent to the department.

In this connection, it is interesting to recall some features of an investigation carried out in the winter of 1911, at Guantanamo Bay, Cuba, by E. J. Grow, Medical Inspector, U. S. N., with the view of determining the relation of visual acuity to actual shooting and whether the gun pointers and trainers should be selected with more consideration as to vision than was then required.

To appreciate just what is required in the way of vision in aiming large guns, it may be well to recall that the telescopic sights used include a proper lens system and in addition a glass on which are etched two lines crossing at right angles, one vertical, the other horizontal.

Accurate aiming implies that both of these lines be seen in sharp focus by the observer. This will not be possible if there is any considerable degree of astigmatism present in the observing eye. The blurring of one of the cross lines may in such a case be so great that it will appear double. Another source of error, if astigmatism be present, is an ocular parallax between the object aimed at and the cross lines.

Experiments by Grow showed that the presence of an amount of astigmatism under 0.75 diopter could be considered a negligible factor in so far as it concerns accurate perception of the telescopic cross lines and the matter of ocular parallax. The records of the vision tests also showed that 20/15 vision practically eliminated the chance of any one having over 0.37 diopter of astigmatism, which is to be considered a perfectly safe amount for the purposes here considered.

Myopia was not found in a single instance among the 270 gun pointers examined, as was to be expected, since all myopes would be eliminated by the requirement of 20/15 vision, as well as by the fact that a myope would be eliminated in any target practice.

With hyperopia, it is entirely different, since a man may have much or little of this error of refraction and still satisfy the 20/15 visual standard. A marked amount of hyperopia is undesirable in a gun pointer, since in the stress of practice or in actual battle, the vision may become blurred from relaxation of the accommodation. Three men out of the 270 examined were found to have 4 diopters of hyperopia, all three of whom had complained of their eyes being tired and vision blurred during target practice. Grow considers that 3 diopters of hyperopia or more should cause rejection of any one as a gun pointer.

He concludes that a visual acuity of 20/15 will in a simple and practical way eliminate all cases of astigmatism and myopia which by any chance would interfere with the most accurate aim which is possible to be obtained through telescopic sights. "Plenty of men," as he says, "can be obtained who have this vision. Nothing is to be gained by a higher visual requirement."

A comparison of the visual requirements of the navies of all the principal belligerent countries before and since the beginning of the war would be at this time interesting and instructive, but with the exception of France and of some meager data concerning the requirements of the British navy it has not been found possible to obtain the data required for such a study.

Visual requirements for the French navy were revised in the latter part of 1915, when it was announced that owing to appreciable loss in recruiting due to more or less rigid requirements certain reductions

would be made in ranks other than pilots, helmsmen, signalers, cannoneers, artificers, armed seamen and buglers. In comparing the French prewar and present visual requirements, together with those of the U. S. Navy, the following may be noted. For the sake of clearness, the French standard expressed in fifths is here reduced to its equivalent in the 20/20 standard.

Helmsmen and lookouts: 20/20 in each eye, prewar and present, which is slightly above the U. S. Navy standard of 20/20 with a minimum of 15/20 in exceptional cases.

Pilots above normal: 20/15, prewar and present, which is also above our requirements of 20/20, with a minimum of 15/20 in exceptional cases.

Torpedo men: French prewar standard, 20/20 each eye; present standard, 20/20 in one eye, 8/20 in the other. U. S. Navy, 20/20 with a minimum of 15/20.

Fusileers (corresponding to our marines): prewar, 20/20 in right eye, 12/20 in left; present, 20/20 and 8/20. U. S. Navy, 20/20 in both eyes; exceptionally, 15/20.

Hospital corpsmen: French prewar, 16/20 and 12/20; present, 12/20 and 4/20. U. S. Navy, 20/20; minimum, 15/20.

Firemen, carpenters, tailors, sailmakers, buglers and members of the band: French prewar, 12/20 and 8/20; present, 12/20 and 4/20. U. S. Navy, 20/20; minimum, 15/20.

Gunners: French prewar, 20/20 and 12/20. U. S. Navy, 20/15 in aiming eye; 20/20 in the other.

The French prewar requirements are not at hand for the following ratings, but the present standards may be compared with those of the U. S. Navy as follows:

Apprentice seamen, seamen first and second class: French, 20/20 and 12/20. U. S. Navy, 20/20; in exceptional cases, 15/20.

Candidates for the Naval Academy: French, 12/20 and 8/20. U. S. Navy, 20/20 in each eye; no deviation.

Medical Corps, civil engineers, pay corps, yeoman school, departmental officers: French, 12/20 and 4/20. U. S. Navy, 12/20 in either eye; correctable to 20/20.

In regard to glasses in the French navy, it is stated that glasses are unacceptable in the service of the fleet.

The visual requirements of the British navy in force before the present war required for men of the deck crew and for naval cadets full normal vision as determined by Snellen's tests. Since the war, candidates have been accepted in the Royal Naval Volunteer Reserve with 20/20 in one eye and 10/20 in the other. Thus the British pre-

war requirements were practically the same or slightly more severe, if rigidly enforced, than those of the United States, but since the war have been somewhat less rigid for the class of men noted.

Candidates for other branches than the deck crew and naval cadets must not have less than 6/60 (2/20) in each eye, which must be correctable by glasses to normal vision. This is considerably below the requirements of the U. S. Navy for men of corresponding ratings.

A question sometimes raised is, To what extent should the wearing of glasses be permitted in naval service? The wearing of glasses by the deck crew of the seaman branch is not practicable, because of fogging of the glasses from sudden temperature changes, fog and spray, and is not routinely permitted. Among men of other ratings, such as yeomen, men in the pay department, and cooks, there is not the same objection, provided the glasses are worn to avoid the discomfort incident to small or moderate errors of refraction and provided the person would not be incapacitated for duty in an emergency, if deprived of his glasses, for it must be remembered that all men on ship board have their assigned battle quarters regardless of rating, and a person who would be helpless for his assigned duty in case of sudden breaking or loss of glasses during battle would be an undesirable member of the organization. This problem, however, is eliminated as one of practical importance by the visual standard required in recruits. since no one with 20/20 vision, or even 15/20 allowed in exceptional cases, will be entirely dependent on glasses. In individual cases the advisability of allowing glasses to be worn is determined by the medical officer in charge.

The method of taking and recording the vision in the navy differs in some respects from that generally used in examinations for the army and industrial institutions. According to the regulations, "Vision is to be expressed as a fraction, of which the numerator shall be the distance at which Snellen's 20-foot test can be determined and the denominator 20." The candidate, one eye being covered, stands before the card at a distance of 20 feet. If he cannot read the Snellen 20-foot letter at that distance he walks forward until he can just do so, the distance at which he can just read the 20-foot letter being, as before stated, the numerator of the fraction expressing the visual acuity.

In 1910, Medical Inspector E. J. Grow, then instructor in ophthalmology in the U. S. Naval Medical School, published a description of the "unlearnable" vision test card devised by him, which has been since then in universal use in the Navy. Grow was led to devise such a card by the following considerations: (1) There is no one absolute standard observed by publishers of Snellen test type, and the cards

of various publishers varied to such an extent that in the case of the line which should be seen at 20 feet (20/20) line, there is a variation in the different charts from 7.4 mm. square to 10.6 mm., as a maximum. Such a variation would make a vast difference whether a candidate, slightly defective in vision, was tested by a card constructed according to the latter or former measurement. (2) The remarkable extremes to which candidates would go to enable them to pass the visual requirements, especially when a life occupation was at stake, simply because they lacked by 3 or 4 feet the ability to read the test letters at the required distance, included the memorizing of the various cards in use such that with the large letter at the top as a key letter candidates would be able to call off all the other letters.

The card contains a series of test letters which subtend an angle of 5 minutes vertically and horizontally at the nodal point of the eye at 20 feet, thus fulfilling Snellen's principles required by the regulations. For the purpose of recording better vision, as, for example, among gun pointers when 20/15 vision is required in the sighting eye, an additional line proportionally smaller is added. The card is mounted in a frame which includes a movable cover containing a vertical and a horizontal slit, by changing the position of which various combinations of letters are brought into view. The card can also be conveniently used unmounted, a piece of cardboard with a slit in the same being held in the examiner's hand serving to cover all lines on the card except the one being used as a test. The use of a single type of card by all medical officers in the service makes for consistency of visual records, and this type of card has proved otherwise eminently satisfactory.

In conclusion, it may be said that the visual requirements of the United States Navy are in general more strict than are those of other leading navies.

There have been no changes, since the beginning of the war, in the regulations governing the visual requirements of the U. S. Navy, and none are anticipated as being necessary or advisable at present or in the immediate future. Notwithstanding the considerable increase in the complement of the Regular Navy and in the Naval Reserve Force and the still greater expansion anticipated in the Reserves, there is, at present, no indication of serious danger of lack of the necessary volunteer recruits who may be enlisted under standards now in force.

In this connection, we may quote a recent announcement of the department. The question arose as to whether men who, while no longer potentially fighting men, would still be able to render limited service should be retained in the service or be discharged by survey.

The matter was referred to the Bureau of Navigation, which announced its decision: "The Bureau of Navigation does not wish to adopt the policy of retaining men who are physically unfit for duty in the Navy but feels that these men should be given their discharge."

Sailor's knot. See **Reef knot.**

Saindoux. (F.) Lard.

Saint Clair's disease. Ophthalmia or "sore eyes."

Saint Vitus' dance. See **Chorea,** p. 2119, Vol. III of this *Encyclopedia.*

Saint With's dance. A synonym of chorea (q. v.).

Saint-Yves, Charles. One of the most important ophthalmologists of all time. Born at Maubert-Fontaine, near Rocroy, Nov. 10, 1667, he entered the College of St. Côme, in Paris, where he studied and practised ophthalmology for more than 25 years. In 1711, however, he established his own private infirmary for eye-patients, where he worked for one more quarter century. He died in 1736.

St. Yves is to be remembered for a number of very important innovations, most of which are described in his great book, *"New Treatise on the Diseases of the Eyes, the Remedies which are Proper Therefor, and the Surgical Operations which their Cure Requires, with the New Discoveries on the Structure of the Eye which Demonstrate the Immediate Organ of Vision"* (Paris, 1722). The most important of the innovations are.

1. The extraction of a cataractous lens. There can be no doubt but that St. Yves was the very first in history to extract a cataract—i. e., *en masse.* The operation of extraction by suction was, as is very well known, invented by an Aram. However, it must be added, in justice to a later inventor, that St. Yves merely removed a lens which had already been dislocated into the anterior chamber. To St. Yves's still greater countryman, Daviel, belongs the supreme honor of having first extracted a cataract *en masse* from its normal position behind the pupil and iris.

2. Though not precisely the first to employ the nitrate of silver in ophthalmology, St. Yves was nevertheless the first to do so to any great extent, as well as to lay down definite indications for the employment of that substance. In order to render clear the exact position of St. Yves with relation to the history of the drug in question, I here subjoin a very brief summary of the whole affair until that master's day.

The substance, silver nitrate, was discovered by the Arabian, Geber, in the 8th century. Albertus Magnus, in the 13th century, mentions the drug, apparently invents for it the term, "lapis infernalis," and adverts to the fact that the substance in question produces a blackening of the skin. Angelus Sala, in the early portion of the 17th century,

was the first (in his "*Septem Planetarum Terrestrium Spagyrica Recensio*") to recommend the medicinal use of the nitrate of silver. He calls the drug "Crystals of Diana," and "The Mastery of Silver." Then, in some vague way, no one knows exactly how, the drug began to be a little used in ophthalmology. Then came St. Yves, who used it plentifully and often. However, he employed it only in ulcers and abscesses, and never, so far as we know, for suppurative conjunctivitis. "So far as we know" I say with especial meaning, for, in his great "*New Treatise*" St. Yves declares that, for children born blind, he has a secret wash, which very often cures them. The secret, however, he reserves for himself and his pupils. It is really more than possible, it is in fact extremely probable, that this great Frenchman was the first to employ the silver nitrate in ophthalmia neonatorum. If this surmise be correct, then the man's unethical conduct has simply removed one very brilliant star from his glittering crown.

3. St. Yves was the first to give an exact description of gonorrheal ophthalmia. Astruc, "*De Morb. Vener.*" (Paris, 1740) describes the disease in a vague and unsatisfactory manner, and so does Bertrandi, in his "*Chirurgie*" (1763). Moreover, "ophthalmia neonatorum" was fairly well described by Severus (who flourished in the 3d. century, A. D.), as reported by Aëtius: "Concerning the Treatment of the New-Born. According to Severus. A terrible disease occurs in the eyes of the new-born. Commonly the lids swell because of the abundance of matter. For moist and warm by nature are the new-born. The collyria against this affection must be cooling and drying, also astringent, in order to relieve the flow of eye-secretions." But the subject of this sketch was the first to describe, with any degree of precision, a case of ocular gonorrhea in the adult.

4. St. Yves was also the first to report a case of gonorrheal ophthalmia produced by conveyance of the contagious secretion from the sexual organ to the eye. The patient was a young man who had long made a practise of washing his eyes every morning with his urine. The practise was continued after he had become a victim of gonorrhea, and so he acquired also gonorrheal ophthalmia.

5. St. Yves was also the first to describe a case of herpes zoster ophthalmicus. However, he did not think of the trouble as an affection of the first and second branches of the trigeminus nerve, but only as a variety of erysipelas. The true conception of the nature of the disease in question was first arrived at by Bärensprung in 1861.

6. St. Yves was also the first to describe the changes produced in the eye by variola.

7. He was the first to make injections into the anterior chamber.

These he carried out by means of a tiny syringe, and for the purpose of removing unabsorbable pus from the chamber in cases of corneal ulceration occasioned by small-pox. The cleansing liquid was simply warm water.—(T. H. S.)

Saint Yves' ophthalmic balsam. See **Balsamum ophthalmicum y veanum,** p. 872, Vol. I of this *Encyclopedia.*

Salah ad-din ibn Jusuf al-kahhal bi-Hamat. A distinguished Syrian oculist, of Hama, who flourished in the latter half of the thirteenth century, and who wrote an important work on ophthalmology, entitled *"The Book, Light of the Eyes and Collection of Divisions."* In the first book of this work occurs the earliest illustration of the eye now extant. For a reproduction of this picture, as well as for a fuller consideration of Salah ad-din and his work, see **Ophthalmology, History of,** p. 8719, Vol. XI of this *Encyclopedia.*—(T. H. S.)

Sal alembroth. An alchemic term for a poisonous compound of sal ammoniac and corrosive sublimate (chlorides of ammonium and mercury), supposed to have the property of dissolving bodies and separating metals from their ores. A one-per-cent. solution has been used by Sir J. Lister in the preparation of antiseptic dressings for wounds. It also forms the basis of Mackenzie's eye lotion—both simple and compound—still largely prescribed in Scotland. See p. 7566, Vol. X, of this *Encyclopedia.*

Salamander, The. In ancient Greco-Roman times the blood of a salamander was employed as a depilatory for the eyelashes.—(T. H. S.)
See, also, **Transplantation of animal eyes.**

Sal ammoniac. See **Ammonium chloride,** p. 325, Vol. I of this *Encyclopedia.*

Salbe. (G.) Ointment.

Sal digestivum Sylvii. See **Potassium chlorid.**

Salicin is a crystalline glucoside obtained from the bark of the *Salix alba* and other species of Salix (willows), and also from the bark of several species of Populus (poplars). It occurs in small white crystals, without smell, but having a very bitter taste; is soluble in 28 parts of cold water, in one part of boiling water, and in 60 parts of rectified spirit. When treated with strong sulphuric acid it dissolves with a bright-red color; being a glucoside, it is readily decomposed by suitable chemical agencies into glucose (grape-sugar)and saligenin. Saligenin can be easily oxidized to form salicylic acid. This remedy in doses of 5-30 grains (0.333—2 grm.) is, like the other willow preparations, prescribed in rheumatic and similar diseases.

Salicon. A synonym of phenol or carbolic acid.

Salicyl-arsenate of mercury. ENESOL. A. Terson (*Arch. d'Ophtal.,*

Jan., 1918; abst. *Br. Journ. Ophthalm.*, p. 276, June, 1919) extols the value of *salicyl-arsenate of mercury (enesol) applied locally in certain diseases of the eye.* Enesol is a white powder containing 38 per cent. of mercury, soluble 1 in 25 of water, insoluble in oil. It has been largely used as a remedy, administered by injection, in syphilis, and according to Terson is especially valuable in cases of syphilis, acquired, or more frequently inherited, associated with tuberculosis. Solutions of enesol rapidly undergo decomposition if exposed to air, or even when in sealed receptacles if exposed to bright light. Terson recommends the employment of a 3 per cent. solution, in colored glass ampoules, containing 2 to 5 cubic centimetres, and prefers a simple aqueous solution to preparations containing glycerine, or to ointments made with vaseline and lanoline. He has found this remedy efficacious in corneal infections from whatever source, in many varities of corneal ulceration, in trachoma, and as an injection into the sac in dacryocystitis. The solution should be applied to the eye freely; Terson's general rule is to use the contents of one ampoule of 2 c.cm., two or more times daily; in some cases he finds it is best applied by means of an eye-bath.

Its employment does not in any way interfere with the use of mydriatics or other remedies.

The tolerance of enesol by a diseased or injured cornea and conjunctiva is, in the words of the writer, "complete." Slight pricking pain and transient congestion follow, but no prolonged reaction. It is, however, very different if the solution be injected subconjunctivally; this is followed by severe pain and much swelling of the conjunctiva. If applied in this way, a much weaker solution (1 in 500 or 1 in 1000) should be employed.

Salicylate of sodium. See **Sodium salicylate.**

Salicylic acid. ACIDUM SPIRICUM. ORTHO-OXYBENZOIC ACID. See p. 72, Vol. I, *Encyclopedia;* as well as **Sodium salicylate.**

Whitham (*Oph. Year-Book*, p. 39, 1913) reports briefly a series of experiments on rabbits with regard to the excretion of compounds of salicylic acid in the ocular humors after internal administration. The acid was locally excreted in the largest amounts after the ingestion of hexamethylenamin salicylate. The amount excreted slightly increased after hot applications to the cornea, more so after paracentesis, greatly after instillation of 10 per cent. dionin solution, and markedly after subconjunctival injections of physiologic salt solution. The growth of the pneumococcus was partly inhibited in aqueous taken from the eye of a rabbit fed with the drug.

Salinas, Franciscus. A famous musician, blind from birth. He was

born at Salamanca, Spain, in 1513. He began to study music when still a child. Later, at the University of Salamanca, he studied also Greek, Latin and philosophy. He became musician to the King, but afterward went to Italy, where he studied for thirty years. He then returned to Spain, but soon went back to Italy. Then again he returned to his native land to accept the chair of music at the University of Salamanca. By Pope Paul the Fourth he was created Abbot of San Piaciato della Rocca Salegna.

He wrote a very thorough work entitled "*De Musica*," which remained for many years a high authority on every portion of its intricate subject. He also invented a number of musical instruments.

Salinas died in February, 1590, aged 77 years.—(T. H. S.)

Salivary glands and the eye. See **Mikulicz's disease**, p. 7703, Vol. X of this *Encyclopedia*. Probably the most complete account of this affection is given by Ziegler (*N. Y. Medical Journ.*, Dec. 11, 1909).

Salmon patch. HUTCHINSON'S PATCH. See **Keratitis, Parenchymatous,** p. 6791, Vol. IX of this *Encyclopedia*.

Salmo thymallus. THE GRAYLING. The oil (axungia) of this fish has been used empirically in caligo corneæ.

Salol. PHENYLIS SALICYLAS, U. S. PHENYL SALICYLATE. This salt is a phenylic erster of salicylic acid. It is a white, crystalline powder, sparingly soluble in water, and has a faint, aromatic odor. This antiseptic salt depends upon its components into which it is readily decomposed by the tissues. As a local antiseptic its value is limited by its slight solubility in water (1-2,400). It is rarely used topically in eye diseases, but as an anti-rheumatic remedy in iritis and glaucoma, in doses of one to three grammes (15 to 45 grains) or more, daily.

Salomon, Christian. A surgeon and ophthalmologist of St. Petersburg, Russia. He was academician, Fellow of the Medical Council and full professor of surgery and clinical ophthalmology. His life dates are not known.

Salomon's ophthalmologic writings are as follows: 1. Beiträge zur Anatomie des Auges. (*Graefe's und Walther's Jour.*, 1825.) 2. Beschreibung einer im J. 1823 zu Oranienbaum Beobachteten Contagiösen Augenentzündung. (*Petersb. Verm. Abhandl. der Heilk.,* 1825, Samml., 3.)—(T. H. S.)

Salomon, Jakob. A well-known German physician and ophthalmologist. Born at Schleswig Sept. 24, 1801, he received his medical degree in 1823 at Kiel, presenting as dissertation "De Pupillæ Artificialis Conformatione." He then, until his death, practised at Schleswig both as ophthalmologist and general practitioner. He died at his home April 21, 1862. According to Gurlt, he was highly honored both as doctor and as man.

In addition to his graduation dissertation, above-mentioned, his only ophthalmologic writing was "Beitrag zu den Beobachtungen über das Eindringen Fremder Körper in dem Augapfel" (*Graefe u. Walther's Jour.*, XIV., 1830.)—(T. H. S.)

Saloop. See **Sassafras.**

Salpetersäure. (G.) Nitric acid.

Salt, Common. Chloride of sodium, or common table salt, was an esteemed ophthalmic remedy in ancient Greco-Roman times. For epiphora, cloths soaked in salted milk were bound about the forehead or the eyes. Salt water, either alone or mixed with myrrh and honey, was also employed in the after-treatment of operation wounds, and trachoma and pterygium were thought to be favorably influenced by hot brine baths.—(T. H. S.)

One of the applications of *normal salt solution* is reported by Edward Heckel (*Penn. Med. Journ.*, April, 1916). In view of the natural vulnerability of the gonococcus when exposed to heat or cold, the fatal temperatures in each direction being respectively 32° Fahr. and 107° Fahr., this writer determined to try the effect of treatment by cold only. He reports on three cases, in one of which 1 per cent. silver nitrate was instilled on two occasions. The second case had been under treatment before being seen by Heckel, while, in the third, iced salt solution was used to the exclusion of all other treatment. Flushing with about a quart of iced salt solution was carried out every six hours, and during the intervals continuous iced pads were employed. The first case was an adult, the other two were in infants. In the first and third cases the eyes returned to normal in four days. In the second case (the one which had had previous treatment), the cold treatment was "very effective." See, also, **Sodium chloride.**

Salter, Richard Wash. A prominent ophthalmologist and oto-laryngologist of New Orleans, La. Born in New Orleans, he was the son of Thaddeus S., and Mary Drummond, Salter. His medical degree was received from the medical department of Tulane University, New Orleans, in 1892, whereupon the Doctor proceeded to the study of ophthalmology and oto-laryngology in New York, Londan, and Vienna. Returning to New Orleans, he soon was widely known as a skilful operator, especially on the eye. In 1908-18 he was connected with the New Orleans Eye, Ear, Nose and Throat Hospital. His death, which occurred July 7, 1918, is said to have resulted from a pistol wound in the head, self-inflicted with suicidal intent. He is survived by his widow (born Edna Bosse),his stepmother, Mrs. T. S. Salter, and two sisters, Mrs. J. E. Schenck and Miss Jane Salter, all of New Orleans.—T. H. S.)

Salvarsan. ARSPHENAMIN. ARSENOBENZOL. 606. This is the proprietary name for dioxydiamidoarsenobenzol. The therapeutic success of complex chemical compounds containing a large proportion of arsenic led to the hope that one of these might prove to be a cure for syphilis. In certain diseases due to protozoa, Ehrlich, of Berlin, tried no fewer than 605 such compounds without success, but the very next one displayed marked beneficial action. The discovery was given to the public on June 22, 1910, when Ehrlich christened the drug "Hata," named after a fellow-worker, a Japanese. In the flood of literature which immediately arose, the remedy was generally called "606," but it is now known as salvarsan. In some cases its effects are little short of marvelous, although its claim to be a specific for syphilis has not been proved.

Besides syphilis it has also been employed in the treatment of yaws, pernicious malaria, pernicious anemia and other protozoan infections. It is a yellowish powder which rapidly oxidizes on exposure to air, and is, therefore, put up in vacuum tubes. As the acid solution is very painful to use the substance is converted, immediately before injection into an unstable sodium salt by the addition of sodium hydroxid solution. The administration is made either deeply into the muscles of the buttock or else subcutaneously. The average dose is 0.5 gm. for each 60 kilos of body weight. The remedy is now officially (U. S.) known as (National Research Council: *Am. Journ. of Ophthalm.*, p. 536, July, 1918) *arsphenamin.* Especially since the outbreak of the Great War a number of other arsenical compounds (probably) equally effective substitutes for this agent have been discovered. These are described and their curative qualities discussed elsewhere in this *Encyclopedia.*

See, e. g., **Salvarsanized serum**; also, **Neosalvarsan**, p. 8304, Vol. XI; also under (the treatment of) **Syphilis.**

After 1915 this German proprietary remedy practically ceased to exist in the allied countries and its place in practical therapeutics was taken by other equally effective, and in some instances identical, arsenical agents. In the United States it was known and widely employed as arsphenamin; in Canada its place was taken by arsenobenzol. Among the numerous other substitutes for this exceedingly valuable antisyphilitic remedy may be mentioned *galyl, kharsivan* and *luargol.*

Among the earlier observations of the remedy are the following: The Editor (*Prac. Med. Series, Eye*, p. 188, 1911) pointed out that the therapeutic qualities of this powerful arsenical compound are still under discussion and continue to be the subject of numerous

investigations. So far as the eye is concerned it may with truth be said that it is a valuable acquisition. There can be no doubt whatever but that *the majority of ocular syphilitic lesions are promptly affected by the injection of a single dose of the remedy*—just as are luetic changes elsewhere. It seems, however, that salvarsan is subject to the same limitations in treating the ocular tissues as are found in other parts of the organism. That is to say, the tertiary affections of the nerve supply are not much influenced by it; indeed, it is still a moot question whether the various forms of optic atrophy are not made worse in many instances by the use of salvarsan. Until it is decided whether or not an existing disease of the optic nerve is or is not likely to be improved by the hypodermic use of 606, it would be well for the ophthalmologist to exercise caution in its employment. Until we have had further light on this subject the possibility of making the patient blind by implication or further implication of his oculo-nervous apparatus, should always receive consideration. In any event, one must not forget that he is making use of a powerful preparation of arsenic, and all arsenical compounds, as we know, are prone to affect the optic nerve in patients predisposed to its influence.

The *Monthly Cyclopædia and Medical Bulletin* of February, 1911, abstracts a paper by W. A. Pusey (*Journ. Am. Med. Assocn.*, Jan. 14, 1911), and one by W. S. Gottheil (*Med. Record*, Dec. 31, 1910). The first paper may be regarded as, on the whole, adverse to the use of the remedy; the second one rather favorable.

The evidence is becoming increasingly strong, W. A. Pusey thinks, that this agent causes neither permanent and complete destruction of the spirochetes, reversal of the Wassermann reaction, nor removal of the clinical manifestations of syphilis. It does have a striking effect on spirochetes, but the sudden disappearance of spirochetes from lesions is no evidence of an overwhelming attack upon the disease. A little calomel powder dusted on a chancre will within twenty-four hours make it very difficult or impossible to demonstrate spirochetes; and in a patient brought thoroughly under the influence of mercury the difficulty of demonstrating spirochetes is enormously increased. Yet no one attaches weight to these findings as evidence of the cure of syphilis. As for the Wassermann reaction, it can also be made negative by vigorous mercurial treatment—not so readily, however, as by "606"—but no conservative syphilographer regards this as evidence of cure. Experience with mercury shows that a return to positive findings is to be expected.

The most important evidence as to the value of "606" is the effect clinically, and here experience indicates great variability, extending

from cases "refractory" to the drug, showing no effect, to cases with strikingly good results. That in active early syphilis, where the symptoms sometimes entirely disappear, no cure is obtained, is shown by the definite tendency to recurrence recently noted. In cases of active secondary syphilis which the author saw treated with salvarsan the effects were not more rapid or better than would be expected from mercury. In tertiary lesions, particularly those intractable to other treatment, the most striking results have occurred. The hope of a therapia sterilisans magna, however,—the complete destruction of the spirochetes in an infected patient,—is practically abandoned, and two or three additional injections are being used. The recommendation of the use of salvarsan and then mercury, as heretofore, is the last evidence that the new agent is not equal to its proposed mission.

Gottheil reports in detail the results obtained with "606" in 25 cases. In the first 16 cases the emulsion was employed, injected into the muscles of the subscapular region. In the remainder the clear solution was used, 3 cases receiving the injection in the buttocks in two equal doses, the other 6 in the right quadratus lumborum muscle. The latter site seemed to be the best. Almost always the injections were very painful. Of the whole series there was not one case that could be classified as an unusual or astonishingly brilliant result. In 3 cases there was practically no effect in six to eight weeks. In 7 other cases, while there was improvement, it stopped after a time, or there appeared new symptoms of the disease, as follows: Periostitis patellæ in three weeks; reappearance of the eruption, general symptoms, increased Wassermann reaction and return of spirochetes in four weeks; new mucous patches in the fourth week; periostitis of tibia, skin gummata and moist papules at the same period, etc. Of these 10 practical non-successes, 8 had been treated by the subscapular emulsion method and had larger or smaller persistent tumors. Two of the 8 were later operated on, with the finding of necrotic tissue and arsenic-containing fluid in their mass; this had doubtless greatly interfered with the absorption of the arsenic. In the other 6, however, the tumors had disappeared spontaneously at the usual time. Nine cases in the general series the author noted as moderate successes, the symptoms either improving very slowly or the patients leaving the hospital prematurely. Frank success was achieved in only 6 cases; one patient showed disappearance of mucous patch and exanthem, though only observed two weeks; another had pain in the tongue quickly relieved and many ulcerations healed, though only observed one week; another lost condylomata in ten days and skin eruption in nineteen; another had skin and mucous membrane lesions and iritis

healed in one month, etc. Some of these results were probably quicker than could be got from mercury. The author believes that with the new drug we have to reckon with the possibility of damage to the kidneys in a certain proportion of cases. Ten of his cases had renal symptoms, in most instances transitory, though some patients had them when last seen, and one or two had casts. Such occurrences under mercury are extremely rare. For the severe pain, which seems to be an inevitable feature of the "606" injection, he thinks some of the more sensitive private patients will demand anesthesia. Preliminary careful physical examination for lesions of internal organs should never be omitted; and rest in bed under skilled observation for several days or a week after the injection is a necessity.

Of the more important contributions to ophthalmic therapy and toxic amblyopia in this connection the following form fair examples.

In nine cases of syphilitic parenchymatous keratitis no beneficial effect could be observed by W. Lohlein (*Wien. Klin. Rundschau*, May 7, 1911), after the injection of salvarsan. Later involvement of the other eye could not be prevented by the use of the drug. The corneal process was not affected as much by the use of subconjunctival injections as with arsenic.

Otchaposky (*Wiestn. Oft.*, Dec., 1911); review in *Oph. Review*, p. 241, 1912, surveying the literature finds that in interstitial keratitis, as may be supposed from the pretty extensive literature that has already accumulated on this question, salvarsan did not prove the success that had at one time been looked for. Like mercury and iodide it was only occasionally of any value. According to Steindorff, of 120 cases of interstitial keratitis treated with this remedy only 45 showed benefit, while in the remaining 75 not only did the case run the usual course, but also the affection developed in the other eye while under the influence of the drug. The best results were obtained in recent cases, while it proved of no value in old standing cases or in relapses. The explanation that the uselessness of the drug in this disease is due to the fact that, as the cornea has no vessels, the drug is unable to reach it, is rendered doubtful by Lohlein who states that he was able to detect arsenic in the cornea after its administration, and further that the use of salvarsan as a subconjunctival injection gave no better results.

The author of the paper under review used salvarsan in four cases of *interstitial keratitis*, two of which were due to hereditary syphilis and two to acquired. In one case the injection of salvarsan was followed by a violent exacerbation, which, however, yielded to treatment by mercurial inunction. In the second case, which was a mild one, the

injection of salvarsan was followed by an increased rate of absorption of the corneal opacities. In the third case salvarsan had no effect, but energetic mercurial treatment was followed by improvement. In the fourth case, that of a woman of 22, who had been infected with syphilis five years previously, the interstitial keratitis which had lasted with relapses for two years, had now been quiet for some considerable period, but had left opacities in both corneæ. Two intravenous injections of 0.4 grm. salvarsan were given at an interval of two months. Four months later a severe relapse appeared in the right eye.

In syphilitic iritis salvarsan proved more efficacious, but relapses occurred with more frequency than after the usual treatment. The author has only observed the prompt disappearance of iritis in one case, and in this case the iritis had followed the first injection of salvarsan, but was rapidly cured by the second. In another case a severe iritis that was slowly yielding to mercurial treatment rapidly got well after the administration of salvarsan; yet a month and a half later a still more severe form of the disease developed in the other eye. In a third case the iritis improved but a severe cyclitis set in. In four other cases the iris in hitherto healthy eyes became severely affected after salvarsan, and was only cured by mercurial treatment.

A trial of the drug was also made by the author in four cases of tabetic atrophy. In two of these cases there was only perception of light in the better eye and this was unaffected by salvarsan. In the two other cases there was still some measure of useful vision which deteriorated considerably after the use of the drug.

In two cases of old standing paralyses of the ocular muscles the drug was not followed by any improvement.

"Neuro-relapses" were observed by the author in four cases. In one case of recent syphilis, a month and a half after the second injection a complete paralysis of the right abducens appeared; in another inflammation of the left optic nerve. In the third case optic neuritis appeared three months after the second injection. In the fourth case, a month after the second injection, paralysis of the right facial nerve developed, which, however, yielded to mercurial treatment. Three months later on, a severe neuro-retinitis appeared which began to improve after a third dose of salvarsan.

Sydney Stephenson (*Lancet*, Aug. 24, 1912; abstract in *Ophthalmology*, Jan., 1913) believes that most observers agree that the *best mode of administering salvarsan is by intravenous injection.* Two or three maximum doses should be administered at intervals of a few days. Some of the poor results attributed to the drug were probably the result of inadequate dosage, for some had held that small doses

resulted in the production of resistant strains of spirochetæ. In the use of the drug there should be frequent determination of the Wassermann reaction, quantitative as well as qualitative. It had been shown that the administration of salvarsan did not prevent the appearance of new syphilitic symptoms during the period of administration, just as was the case with mercury; this was due to the presence of "nests" of organism, which escaped the action of the initial dose. Experience proves that tertiary symptoms appear earlier after the use of the drug than under ordinary treatment, and to some extent it could be said that the type of syphilis was altered by the new treatment. These appearances were most frequent after the use of small doses of salvarsan, and pointed to inefficient treatment. There was a strong tendency to the use of mercury conjointly with and after the injection of salvarsan with the object of preventing these late symptoms.

General symptoms, seen after the injection of the drug, such as pyrexia, insomnia, sweating, nausea, headache, restlessness, and so forth, were probably the effect of faulty administration rather than of the salvarsan. It was of the utmost importance that the solvent should be freshly distilled water. In eye disease particularly it was of the first importance to prevent local reaction, or the delicate tissue of the eye might be further damaged; such reactions were commoner when insufficient doses were employed. Recently it had been shown that salvarsan was contra-indicated in severe vascular lesions of the eye with a tendency to hemorrhage.

The influence of the drug on the optic nerve was of the first importance to ophthalmic surgeons. Ehrlich had shown in his long list of collected cases that only one case of nerve defect had been found; later workers had averred there was danger to the nerve; but the balance of opinion was distinctly in favor of the drug's innocuous character as regards the healthy optic nerve, and also that it could be administered safely and with great advantage in syphilitic affection of the nerve.

There was no unanimity of opinion as to the curative effect of the new product in ocular disease. At most it appeared to offer one more antisyphilitic remedy, the exact place of which was as yet uncertain. In interstitial keratitis of inherited syphilis, for which mercury was well-nigh useless, salvarsan had on the whole given no better results. A few surgeons had reported good results, but the majority thought the malady little influenced by it. The relief of photophobia was fairly generally attributed to it. Those who claimed good results from its use were accustomed to give several injections. An interstitial keratitis of acquired syphilis was readily relieved by it, but

so it was by mercury. As a rule iridocyclitis of secondary syphilis responded well to the drug and much more quickly than it did to mercury; improvement was generally found the day after the injection. It appeared that when properly given salvarsan presented no particular danger to the body or to the eye; it was most likely to be useful in primary and secondary manifestations, particularly of conditions affecting the uveal tract, but it was well to combine it with mercury.

Igersheimer has discussed the *toxicology of salvarsan.* His experiments show that it is far less poisonous than atoxyl, or other preparations of arsenic. Its strong parasito-tropic, with its slight organotropic effect, are prominent qualities. No case has been observed of injury to the eyes by salvarsan in a non-syphilitic person. The lesions which have followed its use, he thinks, may be explained partly as a reaction of the spirochetes, previously lodged in the walls of the vessels. He believes it does not even create a point of lessened resistance in the nervous system. The cases of papillitis following its use run a more favorable course than those arising in cases of syphilis in which it has not been used. Indicating the importance of repeated injections, he cites his experience with interstitial keratitis. After one injection improvement occurred in 5 per cent.; after two injections in 25 per cent.; after three injections in 36 per cent. Neosalvarsan given to cats in fatal doses caused no lesions of the eye, except that in one case of very chronic poisoning, a few degenerated nerve fibers were found in the chiasm. See **Toxic amblyopia.**

Browning was led to the trial of *salvarsan in sympathetic ophthalmia* by the resemblance of the blood-count in that disease to the blood-count of protozoal diseases. The leukocytes are often 30 to 40 per cent. mononuclear, with corresponding diminution of polymorphonuclear cells. After the injection of salvarsan the proportion of mononuclears falls to more nearly the normal. Thus in one case from 32 per cent. to 12 per cent. within five days, and having risen again to 24 per cent., after a second injection fell to normal. In the seventeen cases he had treated thus, the same thing always happened. The count approached the normal, and the eye became quiet. Browning had seen cases of interstitial keratitis rapidly cured by salvarsan. Other cases it did not appear to influence, probably because it was not persisted in. Marple, who has waited for the "boom" to subside before passing judgment, finds that in interstitial keratitis it slightly diminished the photophobia; but in specific iritis, as others have observed, he finds it quickly causes the disappearance of the nodules or gummata.

Jendralski reports five cases of muscular paralysis, *optic neuritis,*

hemorrhagic neuroretinitis and vitreous hemorrhage following the use of salvarsan. Some of these subsequently improved, while others did not. But there was nothing to indicate they would have been better off had this drug not been used. Bistis, from the analysis of the reported cases of eye lesions following the use of salvarsan, concludes that the drug does produce a slightly lessened resistance of the nervous system to the attacks of the spirochete. But the explanation of Igersheimer seems to be the better supported.

A paper by R. G. Reese (*N. Y. Med. Journ.*, June 29, 1912), contends that the only contraindication to the use of salvarsan in ocular lues is simple atropy of the optic nerve. The reason for this opinion is that there are no cases of tabes dorsalis or general paresis that have been benefited by its use, and in instances of spinal atrophy of the optic nerve—which sometimes accompanies these parasyphilitic affections—the administration of salvarsan has apparently hastened the inevitable end.

The writer considers that the deleterious effects in man are inconspicuous when one finds that more than 60,000 cases have received this potent arsenical compound with no authentic case of amaurosis following its use. In the hundred cases in which the fundi were examined by the writer prior to the injection of salvarsan, and reported by Fox and Trimble, it had no injurious effects on the eye in any way.

He alludes to the wonderful benefits in syphilitic iritis in both secondary and tertiary manifestations.

Regarding neuroretinitis, he says that "routine examination of the fundus in syphilitic cases, which has now become the rule, reveals the fact that mild degrees of optic neuritis are common in syphilis, even without salvarsan, and therefore the neurorecidives are due to syphilis and not to salvarsan." He reports good results in iritis papulosa, parenchymatous keratitis, and chorioretinitis, and it is a standing rule to refer all patients with syphilitic eye lesions—except those with simple atrophy of the optic nerve—to another department for intravenous injection of salvarsan. Opinions differ greatly as to its efficacy in parenchymatous keratitis due to hereditary lues; and in unilateral disease it is only rarely possible to protect the healthy eye.

His conclusions are: (1) salvarsan is a powerful symptomatic remedy for the treatment of luetic eye lesions. (2) It certainly merits attention, especially in combination with mercury and iodine. (3) Its action is more rapid than that of mercury, but it should not replace that valuable remedy, except in selected cases. (4) It should be given intravenously for quick action and for the comfort

of the patient. (5) It should not be given in simple, spinal, non-inflammatory atrophy of the optic nerve.

M'Neil, Robb, and Moll (*Oph. Year-Book*, p. 286, 1912) record what they consider a case of *optic atrophy from salvarsan.* During the second stage of syphilis, 0.6 gms. of the drug was given intravenously with marked benefit to the eruption. Hydrargyrum cum creta was then given. After a month, pain in the jaw and right brow was complained of and the mercury was stopped by the patient. Two months after the injection the right eye was blind from optic atrophy.

Oscar Fehr (*Centralb. f. pkt. Augenheilk.*, June, 1912), believes that in none of 2,700 syphilitic patients treated with salvarsan, has any damage to the optic nerve been observed. The forms of optic neuritis seen after the treatment present the same ophthalmoscopic aspect and the same course as those discovered before the injection, which partly had been treated previously with mercury. Likewise the other ocular affections, which occur after salvarsan treatment, are simply relapses of lues. Only in one case of paralysis of the third nerve in tabes was there reason for assuming a causal connection. A striking cumulation of ocular relapses could not be ascertained. Iritis and relapses affecting the optic and ocular nerves were decidedly less frequent within the last year, which was to be attributed to the more energetic salvarsan treatment adopted. The therapeutic failures of the first period of salvarsan treatment must not be charged to the remedy itself, but to the insufficient doses, for curative results have become better with the perfection of the methods. "We have now," the writer says, "learned to give ten times the former doses without detriment to the organism and especially to the eye. The best results are noted in those ocular affections in which mercury is also effectual. The action of salvarsan is undoubtedly more energetic. It is of especial value when irreparable damage is to be feared from the long duration of the syphilitic process. In affections in which mercury is of doubtful value too much must not be expected from salvarsan. It helps, however, in a series of cases where iodine and mercury have failed. It will take years to gain a final judgment on the value of salvarsan. Our experiences so far are such that there is no reason for pessimism, and it is our duty to continue our efforts for trying Ehrlich's remedy, which is at least a valuable addition to our weapons against syphilis."

Wernicke (*Zeitschr. f. Augenheilk.*, May, 1913) reports *10 cases of optic neuritis or neuroretinitis after injections of salvarsan,* of which at least nine were likely due to the drug, or were not prevented by it.

The specific action of mercury in these cases rather indicated the luetic character of these relapses. Since the introduction of salvarsan, no case of neuritis has been observed after mercurial treatment, so that the frequency of the neuro-relapses after injections of salvarsan cannot be merely accidental. As bearing on the inefficacy of the agent, in the summer of 1912, a death was observed at Odessa after an injection of salvarsan. Since then injections of salvarsan have been almost entirely discarded, and no case of optic neuritis has been observed, nor one after mercury. The author emphasizes that in spite of this, Wernicke thinks that salvarsan acts well and rapidly in many severe cases and frequently surpasses mercury. In ordinary cases, it will not replace mercury and iodine, but should be used in failure or intolerance of the old specifics, and in affections in which no time is left for awaiting the effect of mercury. Salvarsan is no substitute for mercury, but a last refuge. A case of parenchymatous keratitis and one of paralysis of the abducens are reported, in which salvarsan had no effect, whereas, a case of syphiloma of the ciliary body healed after injection of salvarsan in less time than mercurial treatment would have taken.

A. Siegrist (*Klin. Monatsbl. f. Augenh.*, Vol. LI, ii, p. 657, 1913; abstract in *Oph. Review*, p. 119, Apr., 1914), thinks it probable that the cause of *sympathetic ophthalmitis* is allied to the cause of syphilis. The lesions of both show a histological resemblance, and in both ordinary methods of staining fail to reveal a causal organism: in both cases the disease may remain latent over a prolonged period, and in both mercurial treatment has hitherto yielded the best results.

The first case which he reports occurred in a man aged 60 who had received a perforating injury of the left eye. The globe was enucleated six weeks later, and showed charcteristic histological changes. After another eight days sympathetic trouble broke out in the other eye, but reacted fairly well to inunctions and local treatment. The Wassermann reaction was negative. Subsequently many recurrences of inflammation occurred, the vitreous became increasingly filled with opacities, and vision sank to 0.15. An injection of 606 was followed by much clearing of the vitreous, and by an increase in the vision to 0.9.

In the second case sympathetic inflammation occurred a month after the infliction of a perforating wound. The Wassermann reaction was negative. The first injection (0.3 grm.) was given about a month after the outbreak, and was followed by two others at intervals of twelve days. In each case there was an exacerbation, speedily followed by an inprovement in the symptoms, the eye became quiet after the third

dose, and remained so five months later. No reference is made to the similar observations of Browning and others.

As a contribution to the *toxic amblyopic effects of salvarsan* Kumagai (*Archiv für Augenheilk.*, Vol. 75 pt. 1, 1913; reviewed in *Oph. Review*, p. 342, 1913) records a case of *gummatous papillitis after salvarsan injection.* He quotes the similar case of Scheidemann (*v. Graefe's Archiv*, vol. 41, 1895), and of Gutmann (*Zentralblatt f. prakt. Augenheilk.*, 1907) in which this rare affection was present.

The author's own case was that of a 31 year old man who was treated by a single injection of salvarsan a month after the appearance of the primary lesion. Shortly afterwards the sight of the right eye began to fail and two months later he was seen by Kumagai with the sight almost entirely lost.

When seen he had a typical specific throat and swelling of numerous lymphatic glands. Both eyes were normal externally, but the pupil of the right eye was somewhat larger and feebler in its reaction to light than that of the fellow eye.

On ophthalmoscopic examination the right vitreous was somewhat hazy, but the fundus was quite visible. On the papilla there was seen a prominent greyish-yellow mass which projected over 2 mm. The neighboring retina was hazy, and swollen up like a rampart, beyond which longitudinal yellow radial streaks were arranged. In this part there was also radial hemorrhages. The vessels first came into view from under the mass at the edge of the papilla. The veins were much enlarged and the arteries correspondingly diminished in size. The field of vision was extremely contracted, and central vision reduced to hand movements.

Under treatment with iodide and mercurial injection the mass was rapidly absorbed and two months later the ophthalmoscopic picture was that of a post-neuritic atrophy. Central vision had improved to finger counting at 5 metres, but the field remained very contracted.

Kumagai admits that in the absence of any microscopical examination it is not possible to diagnose a gumma in this case with certainty, but thinks the following points are all against the diagnosis of an ordinary neuritis:

1. The one-sided conditions. 2. The entire absence of any brain symptom. 3. The vitreous haze. 4. The entire absence of any exophthalmos or interference with ocular movements.

The early occurrence of what must be described as a tertiary lesion is very ingeniously explained by Jaddasohn, namely, that a gumma is really due to the increased resistance of the body tissue to the spirochæte, so that while on the one hand the general resistance of the

tissues is increased, on the other hand an increase of the local reaction to the now scanty virus is experienced. On this assumption, Kumagai points out that salvarsan in insufficient doses may very well be responsible for such cases as he describes. In view, however, of the other specific manifestations present, which were typically of the secondary stage, the reviewer fails to quite agree with this explanation.

The author is convinced that severe optic nerve symptoms have in his experience been much more common, and that in the earlier stages of syphilis, since the use of salvarsan than before the introduction of that drug. He is forced to the conclusion that salvarsan possesses the property, when given in insufficient quantity, of provoking more severe affections of special nerves, either through direct action on the syphilitic virus or through indirect action on the body tissues. In this country syphilologists are not contented with single doses, but go on with the drug till the Wassermann reaction ceases to be positive and after that prescribe a lengthy mercurial course. On this account possibly, such cases as the one described have not so far been recorded here.

John Green, Jr. (*Interstate Med. Journ.*, May, 1914) after reviewing the extensive literature on salvarsan and the eye concludes that salvarsan, by acting quickly, is of *most use in acute syphilitic troubles that threaten the integrity of the eye.* Ocular lesions appearing after salvarsan injection should probably be regarded as a further manifestation of syphilis and treated by more salvarsan and mercury. In chronic cases the drug does not do nearly so much good. It does not appear to have any poisonous effect on any of the tissues of the eye. There is certainly no ground for the belief that salvarsan causes atrophy of the optic nerve through a direct toxic effect.

W. C. Souter (*Ophthalmic Review*, Nov., 1914), reviews the paper of Darrieux (*Annales d'Oculistique*, Vol. CLI, May, 1914), on the *treatment of ocular syphilis by salvarsan and neosalvarsan* in 200 cases since the end of 1910. The technique of the injection of 606 intravenously is mainly carried out with a simple Roux's syringe, the amount of fluid introduced being latterly reduced to 1—2 ccm.

Although the inconveniences after 606 are quite definite, those after 914 are limited to slight headaches for a few minutes and some diarrhea, while the patient need not be kept in hospital. No instance of any local eye reaction had been seen after the 500 injections, whilst the author thinks that the dangers of 606 and 914 have been rather exaggerated. Putting to one side a case of thrombosis of the superior vena cava, due to faulty technique, there remains in the 200 cases only one in which papillary or vascular lesions followed 606, and since the

use of improved technique and of 914 no such accidents had been seen. In no case had delayed sequelæ been noted like those described in atoxyl cases.

His conclusions are that arsenic has its maximum action, from a histological point of view in uveal affections, from an anatomical point of view in anterior segment affections, and from a clinical point of view in the acute affections and in those appearing in recent lues. The treatment, therefore, is most efficacious in acute iritis and iridocyclitis, and in the plastic iritis of lues of slightly longer standing. In chronic iritis an improvement is seen in half the cases, but in choroiditis cases this is not constant.

The action of 606 and of 914 is felt in interstitial keratitis, especially in the presence of signs of reaction, i. e., with iris, ciliary body or uvea affected, but modification of the cornea itself indicating arrest of proliferation of the treponema in this organ had not been observed except perhaps once. The retinal affections are rebellious to arsenical treatment, as are the tabetic lesions of the optic nerve and the oculomotor nerves, whereas in the non-tabetic affections of these nerves one can at times get a good improvement, viz., return of sight, increase in fields, and disappearance of paralysis.

Processes of the plastic type are influenced rapidly and equally by mercury and 606, but neither has any influence on interstitial keratitis or on chronic uveitis. In the acute cases arsenic appears to have a more prompt effect, at least on the pains and photophobia, and is to be preferred to mercury, but whatever be its action, its direct effect on the parasites or the modifications of the cellular elements opposing themselves to its proliferation we see that the arsenical compounds, although possessing an apparently specific action, do not compass the sterilization of the organism, which one had hoped for and been led to expect. This is still to be found.

Finally Antonelli (*Ophthalmoscope*, p. 103, Feb., 1915), has reviewed the extensive labors of Colombo (*Annali di Ottalmologia*, Vol. XLI, fasc. iii., p. 207, 1912) who has given a complete *analysis of the literature to the end of Dec., 1911.* Colombo completed Stuelp's statistics, of 470 cases, by adding to them cases subsequently observed, thus arriving at a total of 812. The exactitude of these figures can be but relative, the literature of arseno-benzol being colossal and scattered through every country in the world. Moreover, classification is difficult, and sometimes arbitrary, as, for example, to class as good or bad results cases that are insufficiently followed or badly related or debatable cases. The figures given by Colombo (the names of the authors being suppressed) are:

1. Syphilitic affections of the lachrymal sac.	
Favorable results	2
2. Affections of the eyelids.	
(a) 5 cases of gummata—	
Cure or rapid improvement	5
(b) 2 cases of syphilitic tarsitis—	
(c) 2 cases of rupia—	
Favorable results	4
3. Conjunctiva.	
(a) 4 cases of primary lesion—	
Cure	3
No result	1
(b) 3 cases of syphilitic pemphigus—	
Improvement	1
No result	2
(c) 1 case of blepharo-conjunctivitis—	
Good result	1
(d) 1 case of tertiary ulceration—	
Good result	1
4. Cornea.	
(a) Two cases of syphilitic keratitis with iritis—	
Amelioration	1
No result	1
(b) 201 cases of parenchymatous keratitis (mostly from congenital syphilis)—	
Cure or rapid improvement	53
No result, keratitis of the other eye, slow or doubtful amelioration, relapse after brief delay	148
5. Sclerotic.	
11 cases of scleritis, gummata, irido-scleritis, episcleritis—	
Cure or rapid improvement	9
No result or relapse	2
6. Uveal tract.	
195 cases of iritis, irido-cyclitis, irido-choroiditis, chorio-retinitis—	
Rapid cure or very favorable evolution	121
Negative results or rapid relapses, very slow or transitory improvements	74
Among these cases, 75 were diagnosed: Affections of the uveal tract, especially anterior (iritis, iridocyclitis)—	
Favorable results	61
No result	14

25 diagnosed as affections especially of the choroid—	
Favorable results	10
No result	15
7. Retina and optic nerve.	
(a) 1 case of gumma of the retina—cure	1
(b) 112 cases of optic neuritis and neuro-retinitis—	
Rapid cure or rapid and considerable amelioration	85
No result	34
(c) 52 cases of optic atrophy—	
Some results	19
No result	33
8. Oculo-motor apparatus.	
Stuelp in his figures noted 146 cases of pupillary inequality and rigidity or of extrinsic or intrinsic muscular paralysis in cerebral syphilis, tabes, or general paralysis, pseudo-tabes or pseudo-paralysis, with—	
Cure or rapid improvement	42
No result or relapse	104
54 cases of oculo-motor paralysis (almost exclusively extrinsic) must be added, with—	
Favorable result	26
No result	28
9. Orbit.	
7 cases of exophthalmos, gummata, orbital periostitis, neuralgia of the trigeminus—	
Result favorable	7
10. Sympathetic ophthalmia (non-syphilitic)—	
Result favorable (Fleischer, Siegrist)	3
No result (Flemming)	1

Colombo further remarks that *primary lesions of the ocular appendages*, as well as cutaneous manifestations of the eyelids, are readily influenced by arseno-benzol. Parenchymatous keratitis due to acquired syphilis is sometimes benefited, but the classic disease of inherited syphilis does not appear to be much under the influence of the new treatment, more especially when we remember the variability shown by the evolution of these cases, their usually favorable prognosis, and the slow but almost certain improvement given by almost all forms of treatment. It is, above all, affections of the uveal tract which are under the influence of arseno-benzol (Stuelp, 65 per cent. and Colombo, 63 per cent.). Notably in iritis and irido-cyclitis the remedy yields brilliant results (81 per cent. in Colombo's statistics). In urgent cases, in order to obtain a rapid improvement or cure,

arseno-benzol should be exhibited, and in order to prevent relapses and to consolidate the cure, it should be followed by mercury. It should not be forgotten that even the classic mercurial treatment acts brilliantly upon iritis and irido-choroiditis, and much more quickly and surely in those diseases than in cases of choroiditis, especially since affections of the iris exact immediate attention from the patient and the medical man, do not remain latent and are not treated too late, as is often the case with choroiditis and choroido-retinitis. In retinitis and neuritis, especially when acute and of recent origin, arseno-benzol often gives good results. In atrophy of the optic nerve, arseno-benzol, like mercury, gives negative or almost negative results. The same remark applies to oculo-motor paralyses, often capable of being cured more or less quickly when treated soon after their appearance, but not capable of modification when several weeks or months have passed. As to *sympathetic ophthalmia*, the cases treated by arseno-benzol are still too few and the results too doubtful to draw definite conclusions.

Arsphenamin. Neo-Arsphenamin. Arsaminol. The *name salvarsan* was dropped from American (including Canadian) patriotic medical literature after 1917 and the terms *arsphenamin, neo-arsphenamin, arsaminol, arsenobenzol,* etc., employed for practically identical substitutes manufactured in America.

Arsaminol is simply a brand of arsphenamin, manufactured by the Takamine Laboratory, and marketed in tubes containing doses from 0.1 grm. to 0.6 grm.

The administration of arsphenamin. The *Journ. Am. Med. Assocn.*, May 10, 1919, has the following on this subject: The subjoined letter from Dr. George W. McCoy, director of the hygienic laboratory of the United States Public Health Service, concerns two special points in the administration of arsphenamin, namely, the dilution and the rapidity of administration. His letter is followed by a circular issued by the Public Health Service to all its officers covering the same general subject. Numerous disagreeable results following the use of the various preparations of arsphenamin have led research workers to make a special study of the cause of these accidents. Such studies have indicated that most of the disagreeable results are not inherent in the preparations themselves, but are produced through faulty steps in the administration of the remedies. The suggestions made in the circular of the Public Health Service, if followed by physicians, will aid in *preventing repetition of disagreeable after effects.*

Dr. McCoy writes: It appears that there is a lamentable want of care on the part of many physicians who administer arsphenamin as

to the concentration of the drug used and the time required for administration.

The Hygienic Laboratory receives many complaints in regard to untoward results from the administration of arsphenamin made by various American producers. When careful investigation is made it is almost invariably found that the drug has been used in a solution that is too concentrated, and that it has been administered too rapidly. We have reports of a dose of 0.4 gm. being given in a volume of as little as 25 c.c. and injected within thirty seconds. Such practice is abuse, not use, of a powerful therapeutic agent.

If, in addition to the usual precautions as to the use of perfect ampules and neutralization, physicians would give the drug in concentration of not more than 0.1 gm. to 30 c.c. of fluid and allow a minimum of two minutes for the intravenous injection of each 0.1 gm. of the drug (in 30 c.c. of solution) the number of reactions would be very materially reduced. This would necessitate from 30 to 180 c.c. of the solution for the doses usually given and would require from six to twelve minutes for the injection.

The ampule, before opening, should be immersed in 95 per cent. alcohol for fifteen minutes, so as to detect any crack or aperture not primarily recognizable. (Should such a breach be discovered, the contents of the ampule should be discarded. Solution: Cold, boiled, freshly distilled water should be used in all cases except in the case of "arsenobenzol" made by the Dermatological Research Laboratory, in which case hot water is required. No more solution should be prepared at one time than can be given in thirty minutes.

Concentration of the drug: It is desired to emphasize the fact that the concentration of the drug should not be greater than 0.1 gm. to 30 c.c. of final solution. The practice of using concentrated solution is not only in direct conflict with the instructions on the circular, but carries a distinct hazard to the patient.

Method of injection. The gravity method only should be used. Where several patients are to be injected from the same solution, the container for the solution should be graduated. If not already graduated, this can be done in a few minutes by sticking on a strip of adhesive plaster and marking the graduations on this. A convenient way to do this is to have each mark represent 30 c.c. with a long mark for each 180 c.c.; then, if the volume is made up so that each 0.1 gm. of drug is contained in each 30 c.c., the doses can be given accurately. It is a great convenience to have a glass stopcock near the glass tubing which serves as a window just above the needle in order to control the rate of injection. If no stopcocks are at hand, the rate can be

controlled by the size of the needle and the height of the column of fluid. A No. 18 or 20 B&S gage is the best size needle.

Rate of injection: Operators should pay particular attention to the rate of administration and in no case exceed 0.1 gm. of drug (30 c.c. of solution) in two minutes. This point is especially emphasized because it is believed that excessive rapidity of administration accounts for more unfavorable results in the use of arsphenamin than any other one thing.

As a comment on these directions A. Nelken (*Journ. Am. Med. Assocn.*, p. 1695, June 7, 1919) writes: "For the past 18 months, both in private practice and in the out-clinic work at Touro Infirmary, I have abandoned the large dilutions and the gravity method of giving arsphenamin for the syringe and concentrated solutions. During this period, I have given, or supervised the giving of, approximately 2,000 injections of arsphenamin by the latter method. Our routine practice is to dissolve 0.6 gm. of the drug in 20 c.c. of freshly distilled water. The average dose given to an adult man of normal weight is 0.5 gm. and to a woman, 0.4 gm. In fresh infections, especially before the onset of a positive Wassermann test, we commonly give 0.6 gm. to the man and 0.5 gm. to the woman, repeating this dose weekly for three doses, and then give at least two more injections at longer intervals, with mercury and iodids in some form between and following the later injections.

"Not merely once, but hundreds of times, I have injected 0.6 gm. arsphenamin in 20 c.c. of water in from twenty to thirty seconds without the slightest unpleasant results, either immediate or delayed. The slowness of the injection, on which Dr. McCoy lays so much stress, may be of importance when a large quantity of fluid is being introduced, but when the quantity is as small as 20 c.c., rapidity of injection is not significant. Our patients, except a few high-strung persons, are hardly aware that they have taken medication. Even the so-called "nitroid crises" are unusual when the syringe method is used. Since we have been using this method, we have seen less of other complications. We have had no fatalities, only one case of severe nephritis, now entirely well, but one case of jaundice, and four cases of toxic dermatitis preceded by hyperpyrexia. In our series of 2,000 injections, the results will compare favorably with those of other clinics, no matter what method of administration is followed.

"The syringe method and concentrated solutions of arsphenamin, because of greater simplicity of administration and saving of time involved, is the method of choice in a busy clinic. It is at least as safe as the technic advocated by Dr. McCoy.

"At present I rarely use neo-arsphenamin either in clinic or office practice. While I have had experience with all of the preparations of arsphenamin available, I routinely use that put out by the Dermatological Laboratory of the Philadelphia Polyclinic. The fact that we dissolve this preparation in boiling water without hesitation, and that our results have been uniformly good with it, has made us disinclined to change.

"Success in the administration of arsphenamin depends chiefly on the following points: first, the selection of a reliable preparation; second, the use of freshly distilled, boiled water, both for dissolving the arsphenamin and for the sodium hydroxid solution; third, care in selecting the patient and adjusting dosage and frequency of repetition."

Toxicology of arsphenamin. The earliest toxic symptoms noted by Jackson and Smith (*Journ. of Pharmacol. and Exp. Ther.*, Jan. 18, 1919: abstract *Journ. Am. Med. Assocn.*) consisted in a dilatation of the heart, perhaps mainly of the right side at first, a progressively increasing pulmonary blood pressure, and a slow, gradual, but not severe, fall of the systemic pressure. The cause of this rise in pulmonary arterial tension they believe to be due partly to the alkalinity of the solutions of arsphenamin used, and partly to the specific action of the drug itself. With large toxic doses the right heart may have to contract against a pulmonary pressure increased by 100 per cent. above the normal, while at the same time the left ventricle may be contracting against a systemic pressure reduced by 25 to 50 per cent. below the normal. These peculiar conditions may tend to establish a state of increased irritability and instability in the heart, and in rare instances delirium cordis may result. The reactions of the internal organs when arsphenamin is injected are variable, and the reasons therefore are obscure. Apparently both central and peripheral influences are concerned. As a rule, oncometric tracings of the spleen and intestinal loop show a dilatation, while the kidney usually contracts, sometimes in a most vigorous fashion. The toxicity of arsphenamin is not increased by the breathing of high concentrations of carbon dioxid, nor by the injection of calcium hydrate, calcium lactate, or of monosodium phosphate. A number of intermediary compounds occurring during the process of manufacture of arsphenamin were studied by Jackson and Smith. None of these is very poisonous and they cannot account for the variable toxicity of different samples of arsphenamin which may or may not contain traces of one or more of these. The suggestion is made that in those cases in which severe, acute, toxic symptoms suddenly manifest themselves, either

during or shortly after the intravenous injection of arsphenamin, tyramine is more likely to be of benefit to the patient than is any other known drug.

Bory (*Bull. Soc. Méd. des Hôp de Paris,* May, 1919) reports a case of typical arsenical eclampsia developing the fourth day after the fourth injection of *French arsphenamin* with an epileptiform attack, coma with mydriasis, stertor and death. Two similar cases have occurred recently at the center at Troyes in the last six months, and he cites ten other fatalities of the same nature which he has found recorded in recent reports from different centers.

Commenting on these accidents the *Journ. Am. Med. Assocn.* points out that the *death of the patient* which has been observed in some instances to follow the administration of arsphenamin has occasioned much concern to those who are compelled to administer this potent drug in human therapy. Among the symptoms observed in these cases of acute collapse are dilatation of the heart and a fall in systemic blood pressure. So far as can be learned from animal experiments, there may be increased pulmonary blood pressure. The reaction of the internal organs seems to be variable. The occasional toxicity of preparations of arsphenamin has been attributed to intermediary compounds employed or arising during the process of manufacture. A number of these have been tested experimentally at the Hygienic Laboratory of the U. S. Public Health Service. The report is that they are not very poisonous and cannot account for the variable toxicity of different samples of arsphenamin which may or may not contain traces of one or more of them. The possibility that the acute reactions often seen after arsphenamin administration in the clinic may be attributable to precipitates forming in the blood stream has also been suggested by several investigators; but it receives no support from the government pharmacologists. They charge the reaction to the alkalinity of the solutions used for injection and to the specific action of the arsphenamin itself. Wherever the real explanation of the unexpected toxicity may be proved to reside, the management of the symptoms of collapse is a question in practical therapy. Epinephrin has commonly been employed to combat the condition. Jackson and Smith are, however, inclined to recommend a trial of tyramin in suitable cases. Hewlett has already employed it as a blood-pressure raising substance in hypodermic doses of 60 mg. (1 grain). The systemic pressure does not rise so high and the danger of acute dilatation of the heart is not so great as with the intravenous injection of epinephrin, according to Jackson and Smith, but the effects of tyramin are much more lasting. These investigators are

extremely cautious in their advice, however. While they are by no means sure that the use of the drug might in any degree decrease the number of fatalities that from time to time occur under the use of arsphenamin, yet in their own words, they believe it is more logical and more likely to be of real value in these cases than is any other drug with which they are acquainted. This conclusion is far from convincing; but when a real danger exists, every reasonable prospect of averting it deserves some serious consideration.

J. H. Stokes (*Journ. Am. Med. Assocn.*, p. 241, Jan. 25, 1919) advises the employment of atropine in the treatment of acute toxic symptoms from arsphenamin. He believes that the acute "nitritoid" crisis or reaction to arsphenamin is a form of anaphylactic shock, explainable on physicochemical grounds as the result of a precipitation either of the drug from its colloidal solution, or of the colloids of the blood plasma, by the drug, or by an impurity. The reaction following the injection of an acid or only partially alkalinized solution of arsphenamin either too rapidly or in too high concentration is presumably of the same type.

2. The nitritoid crisis can apparently be inhibited by a previous injection of atropin ($\frac{1}{50}$ grain), which further suggests that the reaction is a form of anaphylactic shock.

3. The induction of antianaphylaxis as described above further supports the belief that the nitritoid crisis is a form of anaphylactic shock.

4. The induction of antianaphylaxis in patients exhibiting persistent idiosyncrasy to arsphenamin or neo-arsphenamin has proved clinically useful, and, as a means of increasing their tolerance of the drug, deserves further trial and study.

Neo-arsphenamin. Vasconcelos (*Revista medica*, March 1, 1919) relates that notwithstanding the general opinion that neo-arsphenamin is superior to arsphenamin, his experience has been that the latter is more effectual. He reserves neo-arsphenamin for patients with heart or vascular lesions or tendency to hemorrhage, or with veins difficult of access, or the very nervous. Also for children and when the drug has to be administered by the rectum. For treatment of infants, injection into the colon is the preferable method, he thinks.

According to the P. H. S. the *principal precautions* to be observed in the administration of neo-arsphenamin are: (1) But a single ampule should be dissolved at a time. This drug must not be dissolved in bulk to be given to a series of patients. (2) Cold water only should be used. (3) The dilution should be not stronger than 0.1 gm. of the drug in 2 c.c. of freshly distilled water. (4) A very small

needle should be used, and the time of injection of the dose should be not less than five minutes.

J. R. Latham (*Journ. Am. Med. Assocn.*, July 5, 1919) reports one *fatal case* and observations of *exfoliative dermatitis* and *eye symptoms* after intravenous injections (in the lethal case, 0.8 gm.) of arsphenamin. The eyes from the first showed a *conjunctivitis*, and later gave evidence of *involvement of the deeper structures*. The globes became sunken and flaccid, and there was decided atrophy of the orbital fat. The media became too cloudy to admit of fundus examination. When last seen, there was no optic atrophy. Cultures made of the conjunctival sac showed only the white staphylococcus.

Latham, as the result of his experience, shows: 1. A fatality followed a therapeutic dose of arsphenamin, the equivalent of less than 3 grains of metallic arsenic. 2. Diarrhea and vomiting were absent during all stages of the intoxication. 3. Nephritis was not a marked feature at any time, and appeared only at the end. 4. There was apparently a decided affinity of the poison for the skin or for the trophic nerves supplying it. From first to last all the toxic symptoms may logically be ascribed to impairment of skin function. 5. Arsenic was persistently present in the urine. This was remarkable in the absence of accompanying renal inflammation. 6. There was a high leukocytosis and eosinophilia, the latter related closely to the patient's resistance. The height of the leukocytosis followed that of the fever. 7. Arsenic was found at necropsy in every tissue in which it was sought.

Salvarsanized serum. Johnson, Breaks and Knoefel (*Jour. Am. Med. Assocn.*, Sept. 5, 1914) record the therapeutic use of this remedy in two cases of tabes with optic atrophy by intraspinal injections. One was a well-marked case of tabes with optic atrophy; the other showed little outside of the ocular findings.

The technic of Swift and Ellis was followed. At first the blood was allowed to stand over night to separate the serum, but later separation was effected by centrifugalization and the whole operation completed at one time. The neosalvarsan was dissolved in about 10 c.c. of re-sterilized, freshly-distilled water in a glass syringe, and the blood was aspirated under 40 mm. negative pressure into a 2-ounce skimmed milk bottle of a Babcock tester, so that there was comparatively little exposure of either to the air.

Case 1. W. T. C., man, aged 35, married, no children, lineman, with negative family history, had measles when 7 years old, and eruption without sore throat ten years ago, diagnosed as measles. He knows of no chancre. Vision has been gradually failing during the past year. There are no other symptoms. General health good.

Ocular examination, Jan. 13, 1914, revealed right vision 20/70, left vision 20/200. Tension normal. Pupils show marked myosis, and react to light but very slightly. Visual field: Right shows slight concentric contraction. Left also shows defect involving upper nasal quadrant. Color-sense depreciated to such an extent that the patient does not distinguish colors in any portion of field. Fundus shows nerve heads grayish-white with sharp-cut margins. Fundus otherwise normal in appearance.

General examination, Jan. 14, 1914, is negative except for absence of left knee-jerk. No anesthesia or incoordination. Wassermann reaction is positive. During the period in which patient was under treatment he was seen frequently and the visual fields were charted many times.

Jan. 23, 1914, 0.9 gm. neosalvarsan intravenously. No reaction. January 24, 30 c.c. 40 per cent. serum in normal salt solution intraspinally. Very little reaction. February 10, 0.9 gm. neosalvarsan intravenously. No reaction. Serum unsatisfactory. February 17, 0.9 gm. neosalvarsan intravenously. No reaction. February 18, spinal injection of 30 c.c. 40 per cent.serum. Little reaction. Subjective improvement in vision. March 14, 0.9 gm. neosalvarsan intravenously. March 15, 30 c.c. 40 per cent. serum intraspinally. March 27, intravenous injection of 0.9 gm. neosalvarsan. March 28, spinal injection of 30 c.c. 40 per cent. serum. April 4, 0.9 gm. neosalvarsan and 30 c.c. 40 per cent. serum. In this case no reactions of any kind followed the intravenous injections of neosalvarsan, and very slight reactions followed the intraspinal injections of serum. These consisted of some pain in head and back of neck. Examination following last treatment showed a slight left knee-jerk. April 24, it was found that while visual acuity, as shown by ability to read test letters, had improved but little, the sector defect in left field had disappeared and patient was beginning to distinguish colors. May 24, vision is: right, 20/50; left, 20/100. Color fields were mapped with 1.5 cm. test object.

Case 2. R. W. L., man, aged 37, single, machinist, with negative family history, thirteen years ago had some skin trouble with possible chancre. Patient does not know what diagnosis was made. History otherwise was negative up to two years ago, when vision of right eye began to fail. Vision of left eye began to fail a few months later. For several months right eye has been totally blind. Sight of left has constantly grown worse. Patient had lancinating pains about six months ago.

Ocular examination, February, 1914, revealed right amaurosis. No

light perception present. Left vision 20/100. Entire upper half of visual field wanting. Pupils slightly dilated, right does not react to light directly but consensual reaction is present; left reacts to light very slightly. Patient cannot distinguish colors.

General examination, March 2, 1914, revealed absence of knee-jerks, presence of Romberg sign and marked incoordination of both upper and lower extremities.

March 3, 1914, 0.9 gm. neosalvarsan intravenously. Serum obtained was unsatisfactory. March 10, neosalvarsan 0.9 gm. intravenously. March 11, 30 c.c. of 40 per cent. serum in normal salt solution intraspinally. Quite severe pain in head and back lasting several days. Subjective improvement in vision followed subsidence of reaction. March 24, neosalvarsan 0.9 gm. intravenously, some leakage occurring outside of vein. March 25, 30 c.c. of 40 per cent. serum intraspinally. Infiltration of right arm at site of injection. April 7, neosalvarsan, 0.9 gm. Ulceration present at site of previous injection on right arm. April 8, 20 c.c. of 40 per cent. serum intraspinally. April 21, patient's visual field was practically the same as when first examined but vision had improved markedly. He read 20/40; 0.9 gm. neosalvarsan intravenously and 30 c.c. of 40 per cent. serum intraspinally. Quite a severe reaction followed with pain in back, legs and chest. Right arm improved. April 25, subjective vision worse. May 4, subjective vision improved again. Neosalvarsan, 0.9 gm., intravenously and 30c.c. of 40 per cent. serum intraspinally. Severe reaction followed in a few days. May 18, arm healed. Examination showed that coordination was noticeably improved. Knee-jerks absent. Practically no reactions followed the intravenous injections in this case. May 20, 1914, patient read 20/30 easily and guessed several letters at 20/20. Patient now distinguishing color, and color fields were mapped with 1.5 cm. test object.

Note must be taken of the rapidity with which sight was being lost and the marked improvement which took place following the intraspinal injections.

Salvarsannatrium. Sodium salvarsan; a derivative of salvarsan so prepared that when dissolved in distilled water its solution has the same composition as solutions of salvarsan prepared by neutralization with sodium hydrate.

Salvarsan, Silver. See **Silver salvarsan.**

Salve, Arlt's. See **Arlt's salve,** p. 591, Vol. I of this *Encyclopedia.*

Salve, Guthrie's. The formula of this silver ointment is given by Graefe as: Pulv. argent. nit., 0.2 gm. (gr. iii); Liq. plumbi acet., 0.25 cc. (m 3); Vaselin. alb., 4.0 gm. (ʒj).

In old samples of this salve silver acetate in small quantity will probably be found associated with excess of nitrate. Essentially, the active remedies in the ointment are the two silver salts.

Salves. See **Ointments.**

Salvia horminum. Red-topped sage. This plant, of southern Europe, has a disagreeable smell and bitter taste. The herb and seeds were formerly official. The bitterish, mucilaginous seeds (fruits) were used in ophthalmia. They may be employed, like linseed, to remove foreign substances from the eye. See **Sage.**

Salvia verbenacea. Vervain (wild) sage. This plant, also called *wild clary* and *eye-seed-plant* is a southern European species of milder medicinal properties than *Salvia horminum.* The mucilaginous seeds are used by the laity to remove foreign substances from the eye and were formerly employed in ophthalmia.

Salzsäure. (G.) Hydrochloric acid.

Samarqandi. See **As-Samarqandi.**

Sambucus. Aqua sambuci. Elderflower water. The dried flowers of *Sambucus canadensis* and *niger* are used in medicine. They contain about one-half per cent. of a volatile oil.

Elderflower water, official in the British pharmacopeia, is not uncommonly prescribed as a menstruum for ophthalmic remedies. Lawson (*Text-Book*, p. 538), gives the following formulæ for its use in eczema of the face and eye-lids. In other prescriptions the same adjuvant is occasionally mentioned by him: Boracis, gr. cxx; Glycerini, fl. ʒss; Aquæ sambuci, fl. ℥ii; Aquæ dest. ad., fl. ℥viii. Or: Acid. hydrocyanici dil., m. xl; Aquæ sambuci, fl. ℥ii; Aquæ dest. ad., fl. ℥viii.

Samelsohn, Julius. A well-known German ophthalmologist, founder of the Ophthalmic Institute for the Poor, at Cologne. Born April 14, 1841, at Marienbad, West Prussia, he studied at Breslau and Berlin, at the latter institution receiving his medical degree in 1864. Three years later he settled as ophthalmologist at Cologne. He was a prolific writer and a fairly good operator. He died Mar. 7, 1899, of a long-standing affection of the heart.—(T. H. S.)

Samelson, Adolf. A well-known German-English ophthalmologist. Born in Berlin Sept. 6, 1817, he received the degree of Doctor in Medicine (at Berlin?) and settled as practising physician in a village near Berlin—Zehdenick. Because of his participation in the political upheavels of 1848-49, he suffered a number of months' imprisonment and was deprived of his right to practise medicine. Again attempting to study medicine in Berlin, he was promptly and definitely rejected by the University authorities. Although given by A. v. Graefe an excellent opportunity to study ophthalmology, poor Samelson was

exiled from the capital. For a number of years he studied ophthalmology in Paris, Holland and Belgium, and eventually (1856) settled in Manchester. Three years later his right to practise medicine in Prussia was restored but he continued to reside and to practise in England until his death. From 1862-1876 he was physician to the Manchester Eye Infirmary. His latter years were rendered miserable by an almost intractable trachoma—for which he was treated in Berlin in 1865 by his old and loyal friend, Albrecht von Graefe. He died Jan. 12, 1888, at Cannes, whither he had gone in search of health.

According to Hirschberg, "Samelson was of small stature and delicate build. He had very agreeable manners. On us he made throughout the impression of an Englishman. I myself had very pleasant relations with him. He was good enough to translate my first two works, which I published in English." Samelson wrote but little—an article or two on the iris and one (in the *R. L. O. H.*, XII) on pyramidal cataract.—(T. H. S.)

Samoan conjunctivitis. Epitheliosis desquamativa. This disease of the cornea was for the first time brought under careful observation by A. Leber (Review in *Ophthalmology* from the *Australian Medical Gazette*, of June 7, 1913), and received its name, in the year 1910, in Samoa. It is not restricted, however, to that island group and the neighboring archipelago; its distribution is far more extensive, reaching New Zealand, Tonga, and perhaps Fiji; and it can be traced even to the northernmost islands of the South Sea. Judging from descriptions in the old writings of such explorers as Cook, La Perouse, Hunter, Thompson and others, we must look on its occurrence in those parts, if not quite certainly, at any rate with great probability, as epidemic. The great exacerbations, which it apparently underwent, caused it to be looked on as a new affection, its appearance raising all sorts of superstitious notions. In German Samoa, it appeared anew twenty years ago, in a specially virulent form, and this is the date usually assigned to its first appearance there.

The clinical study of it was impeded by the fact that a genuine epitheliosis may co-exist with other conjunctival diseases of bacterial origin, which latter affections also occur separately at times. Thus, in the first instance, we find a specific conjunctivitis caused by the diplococcus samoensis, with symptoms of extraordinary severity leading to extensive damage to the eye; secondly, a conjunctivitis caused by the diplobacillus Morax-Axenfeld; and, thirdly, a conjunctivitis in the causation of which another bacterium belonging to the group of hemophile bacilli is concerned.

The course of these diseases, while comparatively favorable as they

occur in Samoa, is always aggravated by the superaddition of epitheliosis. See p. 3152, Vol. V of this *Encyclopedia.*

Samphire. *Crithmum maritimum.* According to Pliny the elder, a very useful remedy, when mixed with a porridge of chestnut meal and applied as a poultice to the eye.—(T. H. S.)

Sampsuchon. A plant, no longer identifiable, employed in the days of Archigenes and Dioscorides, as a remedy for eye diseases accompanied by profuse discharge.—(T. H. S.)

Samson. The name means, according to various authorities, "little sun," "sunlight," "strong," "astonishment." Samson flourished in the 12th century B. C. The son of Manoah, a man of the town of Zorah, in the tribe of Dan, the miraculous circumstances of his birth are recorded in Judges XIII. He was judge for twenty years of a district bordering on the country of the Philistines, and the terrible execution which he did upon these people, as well as the manner thereof are too well known for repetition here. The story, however, of the way in which this man of unparalled physical strength, was shorn of that strength, and then blinded, is as follows:

"And it came to pass, when she pressed him daily with her words, and urged him, *so* that his soul was vexed unto death;

"That he told her all his heart, and said unto her, There hath not come a razor upon mine head; for I *have been* a Nazarite unto God from my mother's womb: if I be shaven, then the strength will go from me, and I shall become weak, and be like any *other* man.

"And when Delilah saw that he had told her all his heart, she sent and called for the lords of the Philistines, saying, Come up this once, for he hath shewed me all his heart. Then the lords of the Philistines came up unto her, and brought money in their hand.

"And she made him sleep upon her knees; and she called for a man, and she caused him to shave off the seven locks of his head; and she began to afflict him, and his strength went from him.

"And she said, The Philistines *be* upon thee, Samson. And he awoke out of his sleep, and said, I will go out as at other times before, and shake myself. And he wist not that the Lord was departed from him.

"But the Philistines took him, and put out his eyes, and brought him down to Gaza, and bound him with fetters of brass; and he did grind in the prison house."

The following lines of Milton, himself blind, pictures the probable mental condition of the great blind giant as no other writer has ever succeeded in doing:

Samson's attendant leading him.

"A little onward lend thy guiding hand
To these dark steps, a little further on;
For yonder bank hath choice of sun or shade,
There I am wont to sit when any chance
Relieves me from my task of servile toil,
Daily in the common prison else enjoined me,
Where I a pris'ner chain'd, scarce freely draw
The air imprison'd also, close and damp,
Unwholesome draught; but here I feel amends,
The breath of Heav'n fresh blowing, pure and sweet,
With day-spring born; here leave me to respire.
This day a solemn feast the people hold
To *Dagon* their sea-idol, and forbid.
Laborious works, unwillingly this rest
Their superstition yields me; hence with leave
Retiring from the popular noise, I seek
This unfrequented place to find some ease,
Ease to the body come, none to the mind
From restless thoughts, that like a deadly swarm
Of hornets arm'd, no sooner found alone,
But rush upon me thronging,and present
Times past, what once I was, and what am now.
O wherefore was my birth from heaven foretold
Twice by an angel; who at last in sight
Of both my parents all in flames ascended
From off the altar, where an offering burn'd,
As in a fiery column charioting
His God-like presence, and from some great act
Or benefit revealed to *Abraham's* race
Why was my breeding order'd and prescrib'd
As of a person separate to God,
Design'd for great exploits; if I must die
Betray'd, captiv'd, and both my eyes put out,
Made of my enemies the scorn and gaze;
To grind in brazen fetters under task
With this heaven-gifted strength? O glorious strength,
Put to the labour of a beast, debased
Lower than bond-slave; Promise was that I
Should *Israel* from Philistian yoke deliver;
Ask for this great deliverer now, and find him
Eyeless in *Gaza* at the mill with slaves,

Himself in bonds under *Philistian* yoke;
Yet stay, let me not rashly call in doubt
Divine prediction: what if all foretold
Had been fulfill'd but through mine own default,
Whom have I to complain of but myself?
Who this high gift of strength committed to me,
In what part lodged, how easily bereft me,
Under the seal of silence could not keep,
But weakly to a woman must reveal it
O'ercome with importunity and tears,
O impotence of mind in body strong
But what is strength without a double share
Of wisdom, vast, unwieldly, burdensome,
Proudly secure, yet liable to fall
By weakest subtleties, not made to rule,
But to subserve where wisdom bears command?
God when he gave me strength, to show withal
How slight the gift was, hung in it my hair.
But peace, I must not quarrel with the will
Of highest dispensation, which herein
Haply had ends above my reach to know:
Suffices that to me strength is my bane,
And proves the source of all my miseries;
So many, and so huge, that each apart
Would ask a life to wail, but chief of all,
O loss of sight, of thee I most complain!
Blind among enemies, O worse than chains,
Dungeon, or beggary, or decrepit age!
Light, the prime work of God, to me is extinct.
And all her various objects of delight
Annull'd, which might in part my grief have eased,
Inferior to the vilest now become
Of man or worm! the vilest here excel me.
They creep, yet see, I dark in light, expos'd
To daily fraud, contempt, abuse and wrong,
Within doors, or without, still as a fool.
In pow'r of others, never in my own;
Scarce half I seem to live, dead more than half.
O dark, dark, dark, amid the blaze of noon,
Irrecov'rably dark, total eclipse
Without all hope of day!
O first created beam, and thou great Word,
Let there be light, and light was over all;

Why am I thus bereav'd thy prime decree?
The sun to me is dark
And silent as the moon,
When she deserts the night
Hid in her vacant interlunar cave.
Since light so necessary is to life,
And almost life itself, if it be true
That light is in the soul,
She all in ev'ry part; why was this sight
To such a tender ball as the eye confined?
So obvious and so easy to be quench'd,
And not as feeling through all parts diffus'd,
That she might look at will through every pore?
Then had I not been thus exiled from light,
As in the land of darkness, yet in light,
To live a life half dead, a living death,
And buried; but, O yet more miserable!
Myself my sepulchre, a moving grave,
Buried, yet not exempt,
By privilege of death and burial,
From worst of other evils, pains and wrongs,
But made hereby obnoxious more
To all the miseries of life,
Life in captivity
Among inhuman foes."

The close of the blind man's wonderful career, as given in the *Bible* (Judges xvi, 23-31) runs as follows:

"And the lords of the Philistines gathered them together for to offer a great sacrifice unto Dagon their god, and to rejoice: for they said, Our god hath delivered Samson our enemy into our hand. And when the people saw him, they praised their god: for they said, Our god hath delivered into our hand our enemy, and the destroyer of our country, which hath slain many of us. And it came to pass, when their hearts were merry, that they said, Call for Samson, that he may make us sport. And they called for Samson out of the prison house; and he made sport before them: and they set him between the pillars. And Samson said unto the lad that held him by the hand, Suffer me that I may feel the pillars whereupon the house resteth, that I may lean upon them. Now the house was full of men and women; and all the lords of the Philistines were there; and there were upon the roof about three thousand men and women, that beheld while Samson made

sport. And Samson called unto the Lord, and said, O Lord God, remember me, I pray thee, and strengthen me, I pray thee, only this once, O God, that I may be at once avenged of the Philistines for my two eyes. And Samson took hold of the two middle pillars upon which the house rested, and leaned upon them, the one with his right hand, and the other with his left. And Samson said, Let me die with the Philistines. And he bowed himself with all his might; and the house fell upon the lords, and upon all the people that were therein. So the dead which he slew at his death were more than they which he slew in his life. Then his brethren and all the house of his father came down, and took him, and brought him up, and buried him between Zorah and Eshtaol in the buryingplace of Manaoh, his father. And he judged Israel twenty years."—(T. H. S.)

Sand-blindness. A name applied by Shakespeare to an ocular affection—probably trachoma.

Sand bodies. Refractile bodies, mostly composed of calcic phosphate or similar lime salts, found in certain tumors, psammosarcoma especially.

Sandy blight. A popular term for a form of ophthalmia accompanied by the formation of tenacious pus in the mouths of the Meibomian glands.

Sangsue. (F.) Leach.

Sanguinaria canadensis. Blood-root; which contains a powerful poison and has an occasional action upon the eye. See **Chelerythrin,** p. 2030, Vol. III of this *Encyclopedia.*

Sanguineous cataract. An old term for a false cataract consisting of a fibrinous exudation in the field of the pupil, in the interstices of which minute clots of blood are lodged.

Sanitary legislation, Ophthalmic, of various countries. See **Legal relations of ophthalmology,** in the last third of the section.

Sanoform. Methyl-ester. Diiodosalicylic acid. This drug is the result of the action of iodine on methyl salicylate. A colorless, odorless, tasteless powder, insoluble in water but dissolved by alcohol and ether. In the form of a 10 per cent. ointment or as a dusting powder it is recommended in purulent conjunctivitis.

Sanson, Louis Joseph. A celebrated French surgeon and ophthalmologist, the first to apply diagnostically (not the first to discover) the images known as the Purkinje-Sanson images. Born at Nogent-sur-Seine, Aube, Jan. 24, 1790, the son of a midwife, he received his medical degree at Paris in 1817. In 1823 he was surgeon at the Central Bureau, in 1825 second surgeon at the Hôtel Dieu, and in 1830 associate (agrégé) professor of the Faculty. In 1830 he was chief of

the eye clinic, at the Hôtel Dieu, and in 1836 succeeded the great Dupuytren as professor of surgery. In 1839 he underwent successfully the operation of lithotripsy at the hands of Leroy d'Etoilles, but died Aug. 2, 1841.

The Purkinje-Sanson images are three in number: The first and second, erect, are reflections from the anterior surfaces of the cornea and the lens, the third, however, from the (forward) concave posterior lenticular surface. The first of these images was very well known to the ancients, who, however, believed that it had its origin either on or in the lens. Scheiner was the first to indicate its true source. In 1823, Purkinje, of Breslau, discovered the other two images. For Sanson, however, remained the honor of pointing out, in 1837, the use of all these images for diagnostic purposes—an application which is thoroughly discussed in divers non-historic portions of this *Encyclopedia.*

In addition to various ophthalmologic articles in the *Dic. de Méd. et Chir. Pratiques*, Sanson write *Leçons sur les Maladies des Yeux* (Paris, 1838).—(T. H. S.)

Sanson's images. See **Purkinje-Sanson's images.**

Sanson's operation. See Adams operation under **Blepharoplasty,** p. 1066, Vol. II of this *Encyclopedia.*

Santa Anna, Joaqim José de. A Portuguese ophthalmologist of the 18th century, concerning whom but little information seems now to be procurable. He published at Lisbon in 1793, a book containing 293 pages, and entitled "*Elementos de Cirurgi Ocular Offrecidos a Sua Altezza Real O Senhor D. Jaão Principe de Brasil par Joaqim José desta Corte.*" After the utmost efforts, I have not been able to procure a copy of this book. The work was probably never widely circulated, or of much importance.—(T. H. S.)

Santolina fragrantissima. A very stimulant plant growing in Egypt and the Levant. The fragrant, very aromatic dried herb, sold at Cairo under the name of *babung* or *zeysum*, is used as an anthelmintic, and its juice in ophthalmia.

Santonica. Levant worm-seed. The dried flower-heads of *Artemisia maritima.* Santonica contains santonin, and is used as a vermifuge, especially for seat-worms and round-worms, and for incontinence of urine. In large doses it is mydriatic and diuretic. Over-doses may cause convulsions and vertigo, and give a yellow or pinkish tint to objects seen. See **Santonin.**

Santonin. A crystalline neutral principle extracted from santonica, the latter being defined in the *British Pharmacopeia* as the dried unexpanded flower heads or capitula of *Artemisia maritima*, var. *stech-*

manniana. Santonin occurs in brilliant white flat crystals, which become yellow on exposure to light. It is odorless and almost tasteless; practically insoluble in water. Santonin is used in medicine solely as an anthelmintic, and is especially poisonous to the round worm (*Ascaris lumbricoides*), being much less so the thread-worm (*Oxyuris vermicularis*). It is excreted in the urine, to which it imparts a deeper-yellow color, changing to red if the urine becomes alkaline. On color-vision it has often a peculiar effect, the cause of which has never been satisfactorily determined. Objects appear first purple or blue and then yellow, color-vision becoming finally destroyed. —(*Standard Encyclopedia.*)

See p. 2391, Vol. IV, as well as under **Toxic amblyopia** in this *Encyclopedia.*

Baxler's case (*Oph. Year-Book,* p. 263, 1912) demonstrates the danger from santonin even when given in physiological doses. A child 3 years of age was rendered permanently blind from its use as an intestinal parasiticide.

Santorini, Emissary vein of. A vessel that connects with the cavernous sinus which empties into the lateral sinus.

Sapo. See **Soap.**

Sapo durus. See **Soap.**

Sapo mollis. See **Soft soap.**

Sapo viridis. See **Soft soap.**

Sapremia. Sapræmia. Intoxication due to the presence in the blood of the products of saprophytic and non-pathogenic bacteria. Called also *septic intoxication* and *putrid intoxication.*

Sarcina. A genus of schizomycetes, some species of which, *S. aurantiaca* and *lutea,* for example, are pathogenic. Some observers regard sarcina as a subgenus of *micrococcus. S. aurantiaca* inhabits air, water and "white" beer, producing linoxanthin, a golden-yellow pigment. *S. lutea* is found in the air, the conjunctival sac, human skin, potato, etc., and likewise produces a yellow pigment. Cavara (*Oph. Year-Book,* p. 102, 1913) has suceeded in isolating a Gram-negative sarcina from the human conjunctiva, in an eye which had a streptococcic abscess of the lid. Attempts to cultivate the germ found in this eye failed. The organism was also found in the conjunctiva of the other, healthy eye, and was isolated in pure culture. It developed well on almost all of the nutritive media, forming in the solid media lemon-yellow opaque colonies. It did not liquefy gelatin or coagulated milk, did not produce gas, indol or sulphureted hydrogen, nor ferment any of the sugars. It was a facultative anaërobe, grew in either room or thermostat temperature, and was not pathogenic for animal or human eyes.

Sarcocolla. Various sorts of gum (sarcocolla), were employed by the ancient Greco-Roman physicians, as a menstruum for various ophthalmic medicaments.—(T. H. S.)

Sarcoma. Sarcoma of the eye. Sarcoma is a term adopted by Virchow as the general name for a large and important class of new formations. The tumors now called sarcomata are mainly composed of cells resembling those of some form of embryonic or imperfectly developed connective tissues, rather than those of any part of the adult organism. Their structure, as well as their individual cells, usually suggests an embryonic condition: the cells are imbedded in a structureless matrix; and the bloodvessels are often mere channels between the tumor cells. They are thus distinct from the carcinomata, or cancers proper, which consist of epithelial cells in a framework of fully organized fibrous tissues; though they share with them the property of malignancy. They are generally classified, according to the form of their most characteristic cells, as round-celled, spindle-celled, and myeloid sarcomata. They are most common before middle life, and may occur in any organ of the body.—(*Standard Encyclopedia.*)

This important neoplasm has been extensively discussed under various other captions, notably under the names of organs and tissues of the eye. For example, see **Tumors of the eye**; **Flat sarcoma**; **Iris, Sarcoma of the**; **Eyelids, Sarcoma of the**; **Choroid, Tumors of the,** pp. 2169 and 2173, Vol. III of this *Encyclopedia.* To this matter is added here a few contributions, under following rubrics.

Sarcoma, Annular. Ring sarcoma. See **Flat sarcoma,** p. 5223, Vol. VII of this *Encyclopedia.*

Sarcoma of the caruncle. This is a very rare form of primary epibulbar tumor, histologically like the neoplasm in the conjunctiva proper.

Sarcoma of the choroid. In addition to the matter found on pp. 2168, 2171 and 2173, Vol. III of this *Encyclopedia,* the following reports are given. In a case recorded by Geo. H. Thompson (*Montreal Med. Journ.,* Nov., 1910) Fred Tooke gave the following review of the microscopic examination. "The specimen supplied is that of a globe which has been slightly macerated in the process of bisection, mostly manifested by a small oblique tear of the cornea. The contour of the eyeball has, however, been maintained, and, extrinsically, the globe shows no further pathological manifestation. The intraocular chambers are apparently void of anything suggesting pus or blood, the iris is in position, and no macroscopic indications of adhesions can be determined. Within the vitreous chamber the retina is seen detached

from all points except at the papilla, and it is folded upon itself as a grey, lustreless membrane. In the posterior half of the eye, beneath the retina, one sees a new growth, which lies obliquely, extending to within 2 mm. of the point where the retina is fixed to the globe from a point about midway in the circumference of the globe. This tumor is about the size and shape of a shelled almond, and is of a light gray color, except posteriorly and to one side, where it is distinctly pink-tinged. The tumor mass can scarcely be described as soft, nor, on the other hand, is it as firm as one expects to find in tumors of the sarcoma group. The specimen was fixed in formalin, hardened in progressive strengths of alcohol, and imbedded and cut in celloidin; the stains employed have been hematoxylin and eosin, and Van Giesen's stain.

"Microscopically one sees in the conjunctiva bulbi at its corneoscleral attachment, a very moderate degree of infiltration of mononuclear leucocytes, the vessels are somewhat dilated, and the connective tissue cells swollen, presenting an edematous appearance. An exfoliation of the superficial corneal epithelium is manifest; this has no doubt been mechanical as the substantia propria of the cornea is clear throughout. Bowman's and Descemet's membranes are unimpaired. One filtration angle is slightly distended, and the adjacent canal of Schlemm shows evidence of slight infiltration along its course. The anterior chamber is clear with the exception of a few endothelial cells which occupy the filtration angle just referred to. Scarcely any evidence of an iritis is to be made out; all that one notes is a rather abundant supply of lymphocytes with a slight dissemination of the uveal pigment in the iris stroma. There are no blood cells in the anterior chamber, and nothing suggestive of synechiæ can be determined; the lens is absent, doubtless having been dislocated when the globe was sectioned. The ciliary bodies show the same degree of slight infiltration as the iris, but absolutely no evidence of exudate can be made out extending from them into the vitreous cavity. The sclera is clear and unbroken throughout. The retina is completely detached along its whole length, and is folded upon itself a number of times, doubtless pushed out of position by the large neoplasm lying in front of it. The course and position of the retina is so distorted and irregular that its usual histological features are distinguished with difficulty. The membrane is at least atrophic in respect to the layers of rods and cones and of the ganglion cell layer, large vacuolated spaces suggestive of edematous change occupying most of this area, other points showing a moderate degree of infiltration. The choroid follows the contour of the globe fairly closely although it is separated from it

at a number of points. The choroidal pigment is generally disseminated throughout the stroma which is edematous, the blood vessels are widely dilated, but for the most part are not occupied by blood corpuscles. The pigment cells underlying the membrane of Bruch are somewhat swollen, but "Drusen" or colloid bodies are absent. The arteries throughout the uveal track show but a moderate degree of thickening, while throughout its whole course there is practically no evidence of hemorrhage between that membrane and the separated retina; certainly nothing of recent origin.

"The tumor mass proper springs from a small pedicle of the choroid, which is firmly attached to the sclera. This pedicle consists of a dense network of choroidal stroma in which is intermingled coarsely disintegrated pigment cells as well as a number of round cells which have deeply staining nuclei. A few spindle cells are also present, and a number of these, with some of the rounded variety, can be made out under high power in the innermost layers of the sclera adjoining the pedicle or base of the tumor. The precise characteristics of the sarcoma cells occupying the pedicle of the mass are difficult to define. On examining the tumor under high power, well within the vitreous cavity, its composition of round and spindle cells, closely massed together, can readily be determined; the former variety are much more numerous than the latter which are aggregated into little groups or clusters. The nuclei take the stain much more densely than those of other tissue cells throughout the section, while the cytoplasm is well stained with fuchsin. A number of large blood vessels are seen to be tremendously dilated with orthrocytes, and these at a number of points have broken down into the sarcomatous tissue. In this exudate of red blood corpuscles one may detect an unusually large number of polymorphonuclear leucocytes, as well as several large and small mononuclears and a few eosinophiles. At one point in particular, where these lymphocytes are unusually abundant, not only within the exudate but also along the vessel walls, some evidence of early necrosis is apparent. Except at the point of origin of the tumor, where melanin is abundant, the tumor might almost be regarded as a leuco-sarcoma; however, under high power, fine pigment cells may be made out in a few places, which substantiate the diagnosis of melanotic sarcoma of the choroid."

The clinical histories and histologic conditions of two cases of intraocular hemorrhages in the presence of a hidden tumor of the choroid are given by Reis (*Prac. Med. Series*, Eye, p. 218, 1910). The first was a *melanosarcoma of the choroid* and presented the aspect of hemorrhagic glaucoma. In the second a brownish mass at the lower

ciliary region, which was taken for a tumor, proved to be a solid encapsuled blood coagulum. At the anatomic examination a melanotic tumor of the choroid was found at the lower border of the disc.

While hemorrhages due to necrosis of the tumor have been frequently observed, cases similar to those reported by the author are rare, as shown by his review of the literature. Not in every case of hemorrhages occurring in choroidal tumors, need there be a causal connection between the two, as the hemorrhages may be due to traumatism or may be spontaneous from local frailty of the vessels.

The author warns us against all exploratory operations in supposed intra-ocular neoplasms, since they are apt to produce an extrabulbar propagation or general metastases, and advises enucleation of all blind and painful eyes. He emphasizes that in cases in which symptoms of tumor are missing the apparently spontaneous occurrence of extensive intra-ocular hemorrhage suggests the possibility of the existence of an intra-ocular tumor.

Paul Arcanaraz (*Boletin de la Sociedad de Oftalmologia de Buenos Aires,* Jan., 1915; reviewed in *Annals of Ophthalm.*, p. 156, Jan., 1916), gives details of thirty cases of choroidal sarcoma encountered in an approximate total of one hundred thousand patients. Almost all the tumors were pigmented. A total of fifty-four thousand eye patients treated in the clinic between 1900 and 1913, inclusive, furnished nineteen sarcomas, of which eighteen were melanotic and only one leucotic. Among the cases studied the author distinguishes the following types: 1. The pigment granules are intracellular, each sarcomatous cell containing a certain quantity of pigment. 2. The pigment cells are located in the peripheral parts of the tumor, the central part of the sarcoma being formed of an agglomeration of cells completely lacking in pigment. 3. The pigment cells accompany the blood vessels, occurring around or within these. 4. The pigment granules have no relation with the vessels of the neoplasm, occurring apparently at some distance from them. 5. The pigment granules appear to come from the chromatophores of the choroidal stroma. 6. The pigment appears to be derived from the pigment cells of the retina. 7. The pigment is so thick over the whole surface of the section that no cellular detail can be made out. After decolorization of these sections by the method of Mawas, the pigment cells in various parts of the tumor are found in a state of advanced degeneration. 8. In some sarcomas there are found, alongside cells charged with pigment, others scantily pigmented, and finally others completely lacking in pigment, giving the appearance of a sort of mosaic. The various theories as to the origin of the pigment are

discussed in detail, and the following conclusions are reached: The elaboration of the pigment of melanosarcomas is the exclusive function of connective tissue cells derived from the chromatophores of the choroid. Pigment of hematic origin, in accordance with the theory put forward by Langhans and Gussenbauer, is a rare occurrence in sarcoma of the choroid. The endotheliomas coming from the lymphatic vessels and from the intima of the blood vessels appear to be the only cellular type capable of giving origin to pure leucosarcoma.

In one of two cases reported by J. B. Lawford (*Ophthalmic Review*, p. 97, April, 1915) the pathological report of the first is as follows: The anterior parts of the eye show no abnormality. A lenticular-shaped mass of sarcomatous growth is seen in the choroid in the macular region. The choroid in this situation is about ten or twelve times its normal thickness at the thickest part and is completely filled by the growth, which terminates abruptly at its edges and does not infiltrate the neighboring tissue. There is a slight inflammatory reaction in the choroid at the edges of the growth.

The mass is made up of large roundish cells, each with a well-marked nucleus and nucleolus. These cells are packed very closely and show no definite arrangements except near the edges of the mass, where the original planes of choroidal tissue, consisting of elongated cells, concentrically intersect the masses of sarcoma cells.

The central and inner parts of the tumor are practically unpigmented, but in the part adjacent to the sclera and in the parts bordering on the normal choroid elongated pigment-bearing cells can be seen which appear to represent the original chromatophores of the choroid, while the actual sarcoma cells are apparently unpigmented throughout. Closely packed groups of smaller cells are seen here and there, but signs of very active cell division are comparatively infrequent. The neighboring choroidal vessels are greatly dilated, but the growth itself is poor in blood-vessels.

The sclera is not invaded and Bruch's membrane is intact and thicker than normal, while the chorio-capillaris is destroyed. The pigment epithelium over the tumor has undergone proliferation so as to form a series of small nodular masses on the surface of Bruch's membrane, and the thickening of this membrane already referred to is apparently due to the laying down of a uniform thin layer of fresh colloid substances by the epithelium.

A thin layer of exudate is present between the pigment epithelium and the rods and cones. The overlying retina looks perfectly normal.

B. Castresana (*Siglo Medico*, Oct. 21, 1916; abstract in *Journal Amer. Med. Ass'n.*, Dec. 2, 1916) has encountered sarcomas of the

choroid in the proportion of five or six to each 10,000 patients with eye affections—about the usual average of frequency. He emphasizes the extreme importance of an early diagnosis, and discusses the first signs of the affection as he studied them in three recent cases. One patient is the chief of a bacteriologic service, aged 59. About a year ago he noticed a blurring in the outline of microscopic specimens, with dark specks, but vision for ordinary objects was normal. After about six weeks there came a dark spot in the upper segment of the microscopic field. Soon this dark spot became manifest in ordinary vision, and it gradually encroached more and more on the visual field. The diagnosis of circumscribed hemorrhage or tumor in the choroid was confirmed by a bulging into the vitreous. There never had been pain at any time, although the intra-ocular pressure was slightly above normal. Nothing abnormal elsewhere was found as the eyeball was enucleated, the melanosarcoma being restricted to the choroid. In the second case, a man of 30, about a month and a half after a piece of dirt had been flung into one eye, found that vision in this eye became imperfect, the upper and outer part of the field being shut off. A large tumor was found in the choroid, hard and nonmovable, and slight pain was experienced as the tumor was pressed. In both these cases vision previously had been normal, but the third patient, a man of 60, for ten years had been wearing glasses to correct hypermetropic astigmatism. Four months after a blow on one eye, an oval spot interfered with vision in that eye and objects also appeared distorted, with luminous sensations. In all these cases the eye appeared normal until examined with the ophthalmoscope.

An account of a *pre-retinal sarcoma of the choroid* is given by F. Berg (*Klin. Monatsbl. f. Augenheilk.*, 53, p. 115, 1916), who describes the case of a woman, aged 39, who noticed in January, 1913, a slight transient flickering in her right eye. In September, 1913, vision was greatly reduced. Externally the eye was without irritation; pupil round and reacted sluggishly. Below the optic disc two spherical masses, connected by a bridge, projected into the vitreous. Their color was greyish-white. In the whole area there were no retinal vessels; they disappeared at the border of the tumor and reappeared at its peripheral margin. The tumor did not move on movements of the eye. Tension was slightly decreased; vision equaled fingers at 25 cm. eccentrically.

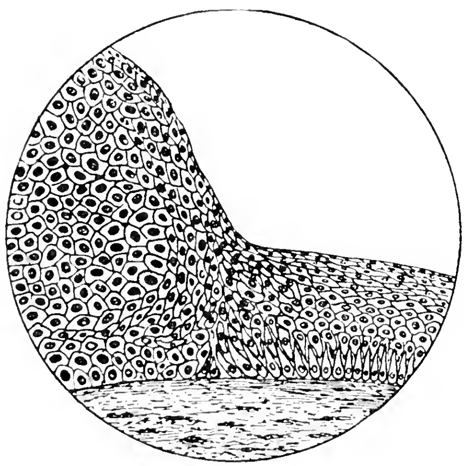
Against the diagnosis of sarcoma of the choroid was the lack of detachment of the retina, so that atypical intra-ocular cysticercus was thought of, especially as there were hemorrhagic opacities in the vitreous. But no eggs of an entozoon could be found in the stool.

The eye was enucleated on Nov. 8, 1913, and fixed in Zenker's solution. It showed a sarcoma of the choroid freely growing into the vitreous, which had perforated a circumscribed area of the otherwise normally situated retina. Such a sarcoma of the choroid is extremely rare. Literature contains only one other case, that described by H. Knapp in his work on intra-ocular tumors, 1868.

For a discussion of the *differential diagnosis* of retinal detachment due to choroidal sarcoma and that due to idiopathic separation, see Domee, under **Retina, Detachment of the,** near the end of the section.

Sarcoma of the ciliary body. See p. 2230, Vol. III of this *Encyclopedia*.

Sarcoma of the conjunctiva. EPIBULBAR SARCOMA. CYLINDROMA OF THE CONJUNCTIVA. A sarcoma of this region is either a leucosar-



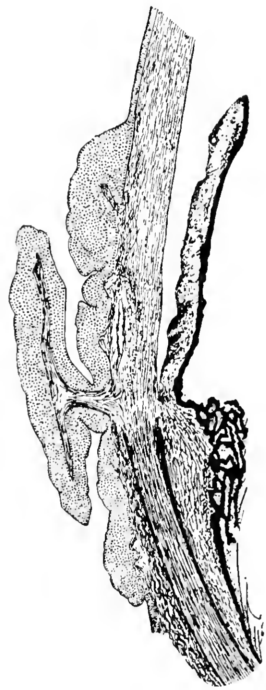
Growth of Conjunctival Epithelioma into the Cornea. (De Beck.)

The epithelial growth is seen extending to either side of the limbus. The flat tumor, resembling a condyloma, is attached to the limbus by a central core of connective tissue.

coma, with or without hematogenous pigmentation, or a melanosarcoma. The former develops from the conjunctival or episcleral vessels, the latter from a nævus pigmentosus. The first sign of the tumor is a growth of the adventitial cells of the conjunctival vessels. When formed, the tumor-mass is rich in vessels. The stroma shows spindle-shaped, round, or polygonal cells lying in close proximity. Cell-nests of varying size may be present, thus greatly resembling carcinoma. Melanosarcomas of the corneoscleral region spring from nevi and often show a structure resembling that of nævus pigmentosus of the con-

junctiva and skin. These so-called "alveolar forms" led Panas to class all melanotic tumors of the corneoscleral region as carcinomas—a view which has been shown by Kerschbaumer to be incorrect.

Early in its history a sarcoma causes no symptoms. After the growth has become larger there is pain and redness. The mass becomes anchored to the cornea and spreads over it. It may involve the whole conjunctiva without penetrating the globe; or it may gain access to the interior of the eye by burrowing between the scleral



Microscopic Section of an Epithelioma of the Conjunctiva Advancing into the Cornea. (De Beck.)

At the right is the normal corneal epithelium; at the left this passes into the irregular cells of the new growth.

lamellæ, or between the corneal layers, or by following the lymph-spaces of the anterior ciliary vessels. When the intra-ocular tissues are involved by an epibulbar sarcoma, increased tension is rarely observed. The melanotic form grows rapidly, often forming metastases. These black tumors are easily recognized. Epibulbar sarcomas occur chiefly in persons above fifty years of age. Three of the reported cases occurred in children. In the writer's case the subject was a middle-aged negro.

Epibulbar leucosarcomas are often confounded with epitheliomas. The latter are flatter, are more cracked, and show a smaller lobulated structure; the sarcomas are elevated, and show a smooth surface or large lobules. The epitheliomas are solid, while the sarcomas are elastic. The former are likely to grow into the lid, while the latter are more apt to spread into the globe. However, it will often occur that the exact nature of a malignant tumor of the conjunctiva can be determined only by microscopic study. This is particularly true if the tumor is removed while yet small. Fortunately sarcoma of this region is rarely seen. Of 67 cases of sarcoma of the eye tabulated by Kerschbaumer, 9 were epibulbar; 5 of these were leucosarcomas, 2 were leucosarcomas with hematogenous pigmentation, and 2 were melanosarcomas. A peculiar form of sarcoma known as *cylindroma* has been observed in the conjunctiva.

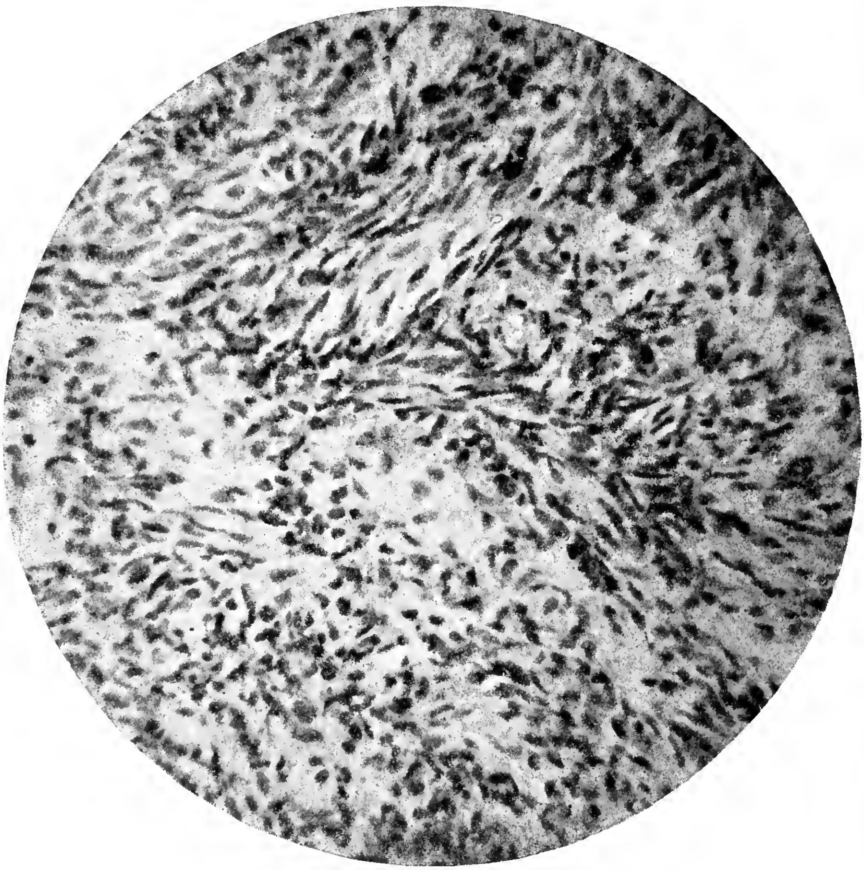
It is possible to mistake an epibulbar sarcoma for tubercular granulation tumors, which pierce the corneoscleral region, or for an intraocular sarcoma piercing the sclera in front. The history of the case should suffice to prevent such a mistake. Danvers states that in some cases the differential diagnosis between the ocular form of spring catarrh and sarcoma of the conjunctiva can be made only by microscopic examination.

Any suspicious tumor growing from the conjunctiva should be subjected to an early and thorough removal. A microscopic diagnosis can then be made and the case carefully watched. If a sarcoma has involved the tissues of the globe, an enucleation will be necessary. The prognosis in these cases is favorable only if the operation be undertaken early. If the tumor involves the capsule as well as the globe, an exenteration of the orbit must be made.—(J. M. B.)

C. T. Wolfe (*Amer. Jour. Surg.*, August, 1915) has reported a case and says that this condition occurs most commonly at the limbus as an epibulbar growth, usually pigmented. Only eighty instances have been recorded. Quoting principally from Parsons, he points out that these tumors grow slowly; they occur usually in old persons, though occasionally in young subjects; they are regarded as highly malignant. Of thirty-six cases in which Verhoeff and Loring reported recurrences, metastasis occurred in eight; recurrence in the lids and orbit in four. The opinion is that primary enucleation should be resorted to. See, also, p. 3075, Vol. IV of this *Encyclopedia*.

Sarcoma of the cornea. Primary sarcoma of the cornea has been described by Panas and others, and as Parsons observes, most of them are not above suspicion as to diagnosis and may well have been endotheliomas. See Parsons' *Pathology of the Eye*, Vol. 1, p. 259, as well as p. 3444, Vol. V of this *Encyclopedia*.

Sarcoma of the eyelid. About fifty cases of sarcoma of the eyelid have been published (Veasey). The youngest patient was 7 months of age and the oldest 76 years. The size varied from that of a pinhead to that of an apple. In rare instances all four lids have been involved, and in 16 per cent., principally children, the dis-



Primary Spindle-cell Sarcoma of the Iris. (Friedenwald.)

ease caused death. There was more or less pigment in 26 per cent. of the cases. The disease returns in probably 50 per cent. In four cases the neoplasm was attributed to trauma. The symptoms are practically those of chalazion. A tumor is present between the skin and tarsus. It develops gradually without pain. In the pigmented cases the discoloration will aid in the diagnosis, which otherwise must remain in doubt until after microscopic examination. The growth is encapsulated to a greater or less extent in about 14 per

cent. of cases. The prognosis must be guarded. The treatment includes excision, the use of radium, and the x-ray. The growth may return locally or metastatically. Veasey states that 38.5 per cent. were spindle-cell, 38.5 per cent. round-cell, and 23 per cent. mixed-cell sarcomas.—(J. M. B.)

Sarcoma of the iris. See p. 6643, Vol. IX of this *Encyclopedia.*

Harry Friedenwald (*Am. Journal of Ophthalm.*, July, 1919) reports a case of primary sarcoma of the iris (see illustration of the photomicrograph) and says Laven (*Klin. Monatsbl. f. Augenheilk.*, p. 493, Vol. 51) notes that about 130 were on record in 1913. The case reported by the writer is an example of the so-called leucosarcomata, and its removal by iridectomy was followed by a satisfactory result during the period of observation (one and a half years).

Sarcoma of the lachrymal gland. This neoplasm, as a pure, primary growth must be very rare. Parsons (*Pathology of the Eye,* Vol. II, p. 753) evidently does not regard as reliable Warthin's catalogue of 132 lachrymal gland tumors in which are listed 14 "sarcomas," 7 round-celled sarcomas, 2 spindle-celled sarcomas, and 2 or 3 mixed sarcomata. They present much the same histological elements as these neoplasms in secreting glands elsewhere.

Sarcoma of the lachrymal sac. This is among the rarest of the new-growths. Sylvestii (*Annali di Ottalm.*, 36 p. 452) reports one case arising from the sac wall which when removed returned in the parotid and orbit.

Sarcoma of optic nerve. See **Intradural tumors**, p. 6553, Vol. VIII, and p. 9079, Vol. XII of this *Encyclopedia.*

Sarcoma of the orbit. See pp. 9186 and 9187, Vol. XII of this *Encyclopedia.*

Sarcoma, Ring. See **Flat sarcoma**, p. 5223, Vol. VII of this *Encyclopedia.*

Sarcoptes scabiei. Itch-mite. This is a minute parasite with numerous pointed tubercles, spines, and hairs on the dorsal surface. The females burrow deep in the epidermis (including that of the lids) to lay their eggs, and thus produce scabies. The mite occurs both in man and in certain of the lower animals, receiving special names. Some of the varieties that usually infest lower animals also attack man, producing a scabies of short duration.

Sarcosis bulbi. An old term for fungus of the conjunctiva.

Sarenko, Wassili. A Russian physician and ophthalmologist. Born in 1814, he received his medical degree in Moscow, and became a military surgeon. He afterwards practised at St. Petersburg. The date of his death is not known. Sarenko's chief ophthalmologic writings

are as follows: 1. De Affectione Oculorum Cacochymica. (1854.) 2. Ueber Glaucom. (*Drug. Sdraw.*, 1838 and 1839.)—(T. H. S.)

Sargent, Elizabeth. A well-known Californian ophthalmologist. Born in Nevada City, Calif., the daughter of Senator A. A. Sargent (who, for a number of years, was U. S. Minister to Germany). She received her medical degree at Cooper Medical College, San Francisco, now the Medical Department of Stanford University. While her father was minister to Germany, she studied ophthalmology at Zürich and Vienna.

Settling as ophthalmologist exclusively in San Francisco, Calif., she soon was widely known as an expert in her profession. In 1883 she became oculist to the Hospital for Children and Training School for Nurses, a position which she held till 1891, when obliged to resign because of failing health.

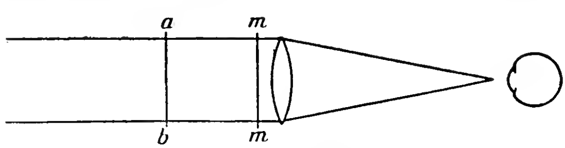
Dr. Sargent never married. She was, however, deeply interested in children, and was devoted to her practice among them. She was also an ardent advocate of woman's suffrage, thus following in the footsteps of her mother.

She died at San Francisco, Feb. 6, 1900.—(T. H. S.)

Sassafras. Cinnamon wood. Ague tree. Saloop. Sassafras bark. Saxifras. The part generally employed in medicine is the bark of sassafras, which contains an important volatile oil (6 to 9 per cent.), some tannin and an active principle called sassafrid.

So far as the eye is concerned the dried pith of the stem (*Sassafras medulla* U. S.) interests us most because from it is made a mucilaginous liquid, recognized officially as *Mucilago sassafras medullæ* U. S., that acts as a soothing and effective collyrium in acute conjunctivitis and serves, also, as a vehicle for more active remedies.

Sattler's keratometer. This instrument is not an ophthalmometer, as the name might imply, but is an adaptation of the Priestley Smith keratometer by Sattler as a means of measuring the cornea or pupil. Objects seen through a convex lens from its principal focus appear



Principle of Sattler's Instrument for Measuring Cornea or Pupil, the observer's eye at the principal focus of the convex lens sees the scale *m m*, and the cornea *a b* equally magnified, although they are different distances from the lens.

of their true size projected on the plane of the lens, however far removed from it. This was the principle of Priestley Smith's kera-

tometer. At one end of a rule is placed a scale, and near it a convex lens having the principal focus at the other end of the rule. The scale being held in front of the patient's eye, and the surgeon's eye placed at the other end of the rule, the observed eye and the scale appear equally magnified. See the figure.

Sattler's layer. The layer of medium-sized vessels of the choroid.

Sattler's solution. SATTER'S EYEWATER. A collyrium used in acute conjunctivitis, recent trachoma and other inflammatory diseases of the external eye: Acid. salicylic., 1.0 (gr. xv); Acid. boric., 15.0 (ʒi gr. xlv); Aquæ dest., 500.0 (fl.ʒxvi).

Saturnine amblyopia. OCULAR SATURNISM. LEAD AMBLYOPIA. See **Toxic amblyopia**; as well as pp. 8342 and 8344, Vol. XI of this *Encyclopedia*.

Saturnine retinitis. See **Retinitis, Saturnine.**

Saturnism. Chronic lead-poisoning; plumbism.

Satyriasis. See **Leprosy, Ocular relations of**, p. 7462. Vol. X of this *Encyclopedia*.

Sauer. (G.) Sour.

Sauerstoffpol. (G.) Anode.

Sauger. (G.) Suction apparatus.

Säule. (G.) Column.

Saunders, John Cunningham. A famous London anatomist, surgeon, and ophthalmologist. Born Oct. 10, 1773, in Lovistone, Devonshire, he studied his profession for the most part in London. In 1804, moved by "the terrible suffering of our troops from ophthalmia in the expedition to Egypt," he founded the Royal London Ophthalmic Hospital, or "Moorfields," the name at the time, however, being "The London Dispensary for the Relief of the Poor Afflicted with Eye and Ear Diseases." The building was in Charterhouse Square, and was very small and inconveniently arranged. It was not opened till 1805. The institution grew rapidly, however. In the first year only 600 patients were treated, but two years after it was founded, its accommodations had to be restricted to ophthalmic patients only, while in 1821 the number of new patients amounted to 5,000; in 1862 to 12,000; and in 1914 to more than 42,000. In 1890 the hospital was incorporated by Royal charter. This institution has been of enormous importance for the development of ophthalmology in England, as every ophthalmologist should know. According to the *London Lancet*, ophthalmologic instruction began to be given at this institution in 1814, and, at the present time, "Moorfields" is a Mecca for students of ophthalmology from every portion of the world. In October, 1851, there began to appear "*The Ophthalmic Hospital Reports and Jour-*

nal of the Royal London Ophthalmic Hospital," of which Streetfeild was the first editor. In 1861 the name was changed to *"Ophthalmic Hospital Reports, and Journal of Ophthalmic Medicine and Surgery"* —an extremely valuable component of modern ophthalmic literature, which was published continuously until its recent merger with other ophthalmic publications to form the *"British Journal of Ophthalmology."*

"Moorfields," it is interesting to note, stands in Moorfields no longer, having been removed in 1899 to City Road, though it still retains the old designation, "Moorfields." It contains 138 beds, as well as a large out-patient department. The present location is very convenient for the densely populated district of Finsbury, Holborn, Bloomsbury, Islington, Clerkinwell, Shoreditch, Hoxton, Haggerston, and the East End of London. The hospital now cares for about 2,500 in-patients annually, as well as more than 50,000 out-patients.

Saunders was a man of middle height, and was cheerful and friendly in manner. He was a great teacher, as well as a skilful operator. He will always be remembered chiefly as the founder of "The Royal London Ophthalmic Hospital." He died of apoplexy Feb. 9, 1810. Saunders' most important writings were: 1. *The Anatomy and Diseases of the Ear.* (London, 1806; 2d ed., 1817.) 2. *Treatise on Some Practical Points Relating to Diseases of the Eye.* (London, 1811; 2d ed., 1816.)—(T. H. S.)

Saunderson, Nicholas. A famous blind professor of mathematics. Born at Thurlston, in Yorkshire, in 1682, he was totally blinded by smallpox when only a few months old. At a very early age he showed decided aptitude for mathematics, and, in 1711, was made professor of the subject in Christ's College, Cambridge. In 1723, he married a daughter of a Mr. Dickens, Rector of Coxworth. His married life was very unhappy, owing, it seems, to his own cross-grained disposition. In 1739 he died.

He is said to have been a cold, heartless, selfish man, whose brilliancy, however, attracted to him a number of scholarly friends. A life of the scientist is prefixed to his *Elements of Algebra,* which appeared in 1740.—(T. H. S.)

Säure. (G.) An acid.

Sausage-poisoning, Eye symptoms of. See **Toxic amblyopia,** as well as **Botulismus**, p. 1253, Vol. II, and **Allantiasis,** p. 240, Vol. I of this *Encyclopedia.*

Cohen (*Oph. Year-Book,* p. 277, 1912) has recorded a case in which papilledema, headache, dizziness, and vomiting followed the ingestion of sausage. Though physical examination revealed nothing abnormal the radiograph showed calcification near the pineal gland.

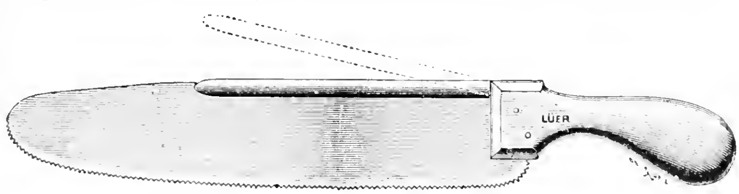
Sauvagesia adima. SAUVAGESIA ERECTA. Also called *iron-shrub* and *herb of St. Martin.* It is a mucilaginous, bitterish, aromatic West Indian and South American species; used in ophthalmia and intermittent fever.

Savage's cataract detacher. See p. 1518, Vol. III of this *Encyclopedia.*

Savage's phorometer. SAVAGE'S CYCLOPHOROMETER. See p. 9667, Vol. XIII, as well as p. 3640, Vol. V of this *Encyclopedia.*

Savaresi, Antonio M. T. A well-known Italian military physician, whose life-dates seem to be unascertainable. He was born, however, in the latter years of the 18th century at Naples, and there received his medical degree. In 1824 he was made physician-in-chief of the Neapolitan Army and First Scientific Fellow of the Milito-Sanitary Commission. His only writing of ophthalmic interest is an article entitled "Description et Traitement de l'Ophthalmie d'Egypte" in Des Genette's *Hist. Med. de l'Armee d'Orient.*, 2d ed., Paris, 1830.—(T. H. S.)

Saws in ophthalmic surgery. A saw is essentially a cutting instru-



Saw with Movable Back. (Lüer.)

Larrey's Fine Saw.

ment with a serrated edge used in operations on bone and other compact tissues. Its use in eye operations is consequently limited to operations on the bony walls of the orbit and of the neighboring cavities, and the types of instruments there employed do not differ materially from those in use elsewhere. See p. 1880, Vol. III; **Krönlein's operation,** p. 6871, Vol. IX; as well as under **Orbit, operations on the,** in this *Encyclopedia.*

A few saws, especially designed for ophthalmic use, are also pictured here.

Saxifrax. See **Sassafras.**

Saxolin. A semisolid preparation of petroleum hydrocarbons resembling vaselin.

Scabies. Itch. See **Pediculosis, Ocular,** p. 9400, Vol. XII (for additional references); as well as **Cornea, Scabies of the,** p. 3446, Vol. V of this *Encyclopedia.*

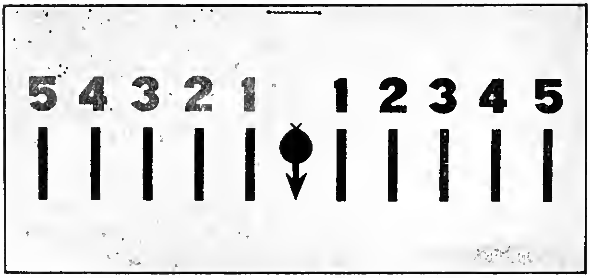
Scabies pruriginosa palpebrarum oculi. (Obs.) Palpebral conjunctivitis.

Scaevola chlorantha. Rice-paper plant. The *taccada* of India and Ceylon. The bitter juice of the fruit and leaves is employed in ophthalmia.

Scalds of the eye. See **Burns of the eye,** p. 1346, Vol. II of this *Encyclopedia.* Here may be mentioned the case of M. Rosenfeld (*Centralbl. f. prak. Augenheilk.*, Oct., 1911) who describes scalding of the cornea and conjunctiva by hot fomentations. A woman, aged 28 years, had been under treatment for recurrent keratitis, and applied to the affected eye hot fomentations for over half an hour. These gave her relief and were in no way painful, but set up the following condition: In addition to much injection, the whole cornea and conjunctiva for about 3 mm. around the limbus were milky-white. The epithelium was raised into many blisters and in some places there were loose tags of epithelium. The patient was suffering from hysteria. She had anesthesia of both hands and forearms and also in the region from the upper lip upwards including both conjunctivæ and corneæ. The condition cleared up, leaving only slight opacities in the lower half of the cornea.

Scale, Maddox tangent. See p. 7576, Vol. X and p. 4682, Vol. VI of this *Encyclopedia.* In addition it may be said here that the scale is for use at a 5 meter distance, and consists of divisions showing the tangents of degrees at that distance.

It may be used in measuring or demonstrating the angle of deviation



Maddox Tangent Scale.

in prisms, the reading being in prism dioptre units. All that is necessary is to hold the prism with the base to the right or left and ob-

serve the position of the arrow. The reading is direct, as, if the arrow indicated "3" the prism is one of three dioptres.

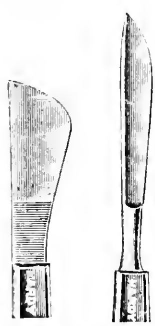
For measuring ex- and esophoria a small light object is placed directly before the black circle on the arrow. A Maddox rod is placed before one eye and the patient reads the figure crossed by the line of light. For convenience the figures to the left of the arrow are red. The figures to the right as well as all the lines are black. See the illustration.

Scale-micrometer. A linear, finely-graduated scale.

Scales, Haab's. See **Haab's scales,** p. 5673, Vol. VIII of this *Encyclopedia.*

Scalpel for eye surgery. A surgical knife of medium size having a convex cutting edge and the blade wider than that of a bistoury. See p. 1002, Vol. II, as well as p. 6862, Vol. IX of this *Encyclopedia.*

Scalpels for ophthalmic surgeons should be small as compared with



Scalpels.

the scalpel of the general surgeon, but they should be strong, with a blade from 3 to 4 centimeters long. The Arlt model with center

Scalpels. a. Arlt's (large), b. Beard's (extra convex).

point and the Beard knife with a blade of great convexity mark the extremes in the shape of the blade.

C. H. Beard (*Ophthalmic Record,* Jan., 1905, p. 6) describes a slight modification of his own scalpel introduced ten or twelve years before. The difference lies in the greater convexity of that part of the edge which is situated near the extremity of the blade.

G. M. Black's pterygium knife closely resembles the Agnew iridectomy knife, but is one-third smaller. (See the *Ophthalmic Record,* Dec., 1897, p. 650.)

H. B. Young (*Ophthalmic Record,* March, 1908, p. 133) has invented right and left knives, the blades being ground into a kidney, or pointless-sickle shape, sharp all around. The short, broad, pointless angular blade allows one to follow perfectly the contour of the globe.

Scalping the lids. This ancient operation is now rarely performed, although in extremely obstinate cases it may be practised. Naturally, it is more to be avoided on the upper than the lower lid, for the lashes of the upper lid are more essential to protection of the eye than those of the lower. It was probably suggested by the practice of the ancients of completely destroying the hair follicles by a hot iron. The method that is usually followed is that suggested by Flarer.—(W. H. W.) See p. 4345, Vol. VI of this *Encyclopedia.*

Scammonium. Scammony. The root of *Convolvulus scammonium* is the part of the plant used (as an anthelmintic and hydragogue cathartic) in medicine. Its active principle is a gummy exudate. In conjunction with colocynth (see p. 2360, Vol. IV of this *Encyclopedia*) it has, according to a report of Scrini (*Bull. di Ospedale Ottal.,* April, 1903), produced marked reduction of vision, edema of the retina, tortuous retinal veins, small arteries and choked disk.

Scaphocephaly. A synonym of *tower-skull* (q. v.).

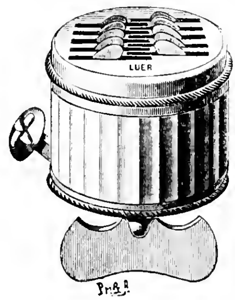
Scapinelli, Ludovico. This distinguished blind Italian poet and man of letters, was born at Modena, Italy, in 1585, and was probably blind at birth. He was patronized by the Duke of Modena, and became the instructor of that sovereign's son. He was later professor of eloquence at the University of Bologna. In 1617, taking a dislike to Bologna, he removed to Modena, where he was made professor of literature. Later still, he was elected to the corresponding chair in the University of Pisa. From 1621 to 1628 he lived in great retirement, owing to ill health. In the last named year, he accepted the chief professorship of eloquence at Bologna. Six years later he died, quite suddenly, at Modena.

A collected edition of his works was published at Parma in 2 octavo volumes, entitled *"Opere del Lettore Lodovico Scapinelli."*—(T. H. S.)

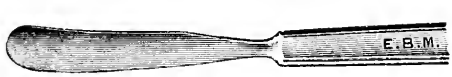
Scardamygmus. (L.) An old synonym for nictitation or winking.

Scarification. See p. 1226, Vol. II and **Artificial leech,** p. 633, Vol. I of this *Encyclopedia.*

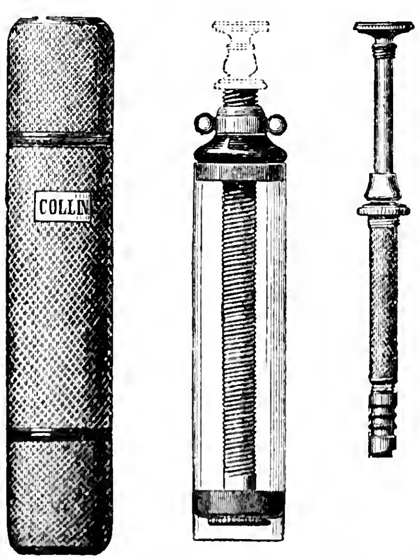
Scarifiers. Ocular scarificators. See **Scarification.** A few of the instruments in this minor ophthalmic procedure not elsewhere described or pictured in this work are described or depicted here.



Spring Scarificator.

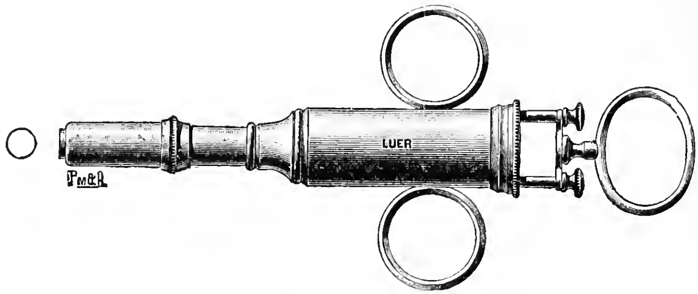


Desmarres' Scarifier.



Scarificator and Artificial Leech. (Collin.)

The most common form—the spring scarificator—is composed of a number of sharp blades so hinged that they may be withdrawn simultaneously into a receptacle and, when the latter is applied to the



Heurteloup's Scarificator.
For the temple, three sizes of circular knives.

part to be scarified, freed by releasing a spring, so that they sweep rapidly through the tissue.

Weeks' scarificator is used for depleting the fleshy, granular masses

Graefe's Scarificator.

of trachoma, and consists of three removable blades mounted in one handle. It is certainly preferable to the single bladed knife in the Desmarres instrument, illustrated in this text.

Scarlatina, Ocular symptoms of. This well-known, acute, generally infantile contagious and exanthematous febrile disorder is probably caused by the *diplococcus scarlatinæ*, or Class bacillus. It begins with chills, vomiting and sore throat, followed by high fever and rapid pulse. In twenty-four hours afterwards the fine, red eruption appears which begins to fade in a few days, after which the skin desquamates in branny scales. Nephritis and various eye, ear, nose and throat sequels often attend or follow the infection.

The eyelids in scarlet-fever present a bright-red color, with more or less edema, and an intense sensation of burning. A catarrhal conjunctivitis accompanied by a more or less severe chemosis is sometimes present. The edema is at times so marked that the patient is unable to open the eyes, and the condition is likely to be mistaken for erysipelas. During the stage of desquamation large, thin scales will separate from the lids. These should not be removed but mild astringent ointments should be applied.

The eyes should be shaded from the light, and the conjunctival infection should be treated with mild boric collyria and simple salves. For the deeper and occasional involvements (secondary or occurring with the nephritic lesions) see the references under **Kidney diseases,** p. 6845, Vol. IX of this *Encyclopedia.*

Dutoit (*Oph. Year-Book,* p. 67, 1909) reports the case of a boy aged 16 months, scalded in one eye the day before the eruption of scarlet fever appeared. Violent conjunctivitis occurred, corneal ulcer developed, and ended in total staphyloma. The discharge contained a few staphylococci, and enormous quantities of streptococci. The latter were also present in the nose, and Dutoit supposes that the injured eye became infected from nasal mucus. Coover reports a case in an adult in which facial and ocular infection occurred from erysipelas in the nostril. Bane also reports the case of a child two months old, in whom rapid softening and destruction of the cornea occurred with scarlet fever; and the streptococcus was found in the nose and in the eye.

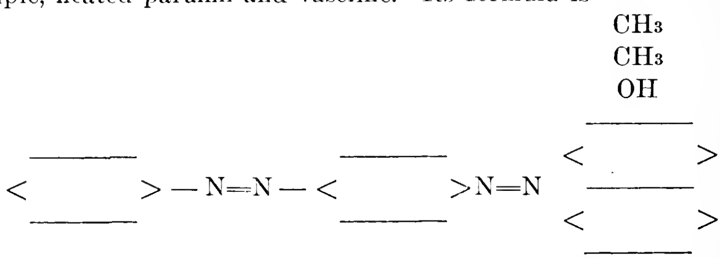
Brief references to other complications of scarlatina are made by Parsons (*Pathology of the Eye,* p. 1323, Vol. IV).

In an epidemic of 2,000 cases of scarlet fever with 200 deaths Giuseppi (*Gaz. degli Osped.,* p. 803, 1918) saw four cases of *corneal ulcer,* two of *iritis,* and four of *panophthalmitis,* which all developed during the course of the disease. One case of corneal ulcer was fatal on the twelfth day, another that developed on the eighth day left the patient blind. One eye affected with iritis had to be enucleated. All of the cases of panophthalmitis were fatal and all ran an acute course. Bilateral mydriasis with ocular hyperemia was noted as always being followed by death within forty-eight hours. This was true even of patients who seemed not very ill when the mydriasis appeared. Giuseppi suggests that this symptom was caused by a severe toxic action on the adrenals and sympathetic nervous system.

Scarlet red. In addition to the matter under **Red, Scarlet,** it may be mentioned here that Richard Cords (*Oph. Review,* p. 230, Aug., 1910, abstract of *Klin. Monatsbl. f. Augenheilk.,* Jan., 1910) after mentioning the animal experiments [which the Editor does not further quote because he does not believe one may draw definite conclusions applicable to human eyes from the effects of drugs on animal eyes] of Fisher and Wessely, speaks of the use by Schmieden and others of "scharlach" red in human therapeutics. Its value has been proved in cases of fresh granulation tissue, as, for example, burns, large deficiencies after operation for carcinoma, and as a dressing for Thiersch

skin-grafting. The resulting scars possess a thick healthy epithelial covering which presents throughout a normal appearance. It has also been reported of value in dirty granulating wounds. Wolfrum and Verf used scarlet red in the treatment of different diseases of the cornea. It did not appear to have much effect on simple erosions, but was successful in deeper and more extensive loss of tissue. In the after treatment of ulcus serpens, descemetoceles, and corneal fistulæ, it proved of much service.

Scarlet red is a red-brown powder which melts at 184°-186° and decomposes at 260°. It is amidoazotoluoazo-B-naphthol and is closely related to sudan. Its reaction is neither alkaline nor acid. It is insoluble in water, dissolves on the contrary in chloroform in proportion 1:14; it is easily soluble in phenol, fats, and fatty oils, as, for example, heated paraffin and vaseline. Its formula is



In an ointment it is important that it be finely divided and well mixed. Schmieden advocates that the dye should be first dissolved in chloroform, but Reinhardt says the warmed ointment basis should be sufficient. Cords used 5, 8, and 10 per cent. ointment. Auerbach says 4 per cent. ointment should have sufficient action.

Cords performed his experiments on rabbits (with one exception, viz., a cat) because he thought [and found out his mistake—Ed.] that their eyes would behave similarly to human eyes. Clinical experience has shown the action on human eyes to be more constant and striking than in animals. He divides his investigations into four different groups and quotes examples from each. Before making these experiments, however, he tried the action of the ointment on normal eyes. In rabbits 10 per cent. ointment on no occasion gave rise to any irritation. The daily application of ointment for 3 or 4 weeks was entirely free from action on normal tissue. In disease of the human eyes sometimes indeed the ointment did act in an irritable manner. This was probably due to a trace of chloroform, which is always present in fresh ointment, and is naturally a severe irritant.

Cords remarks that after considering his experiments and clinical observations on the action of scarlet red in corneal affections he can

say that in almost all the cases it hastened the regeneration of the stroma and the process of cicatrization. Scharlach red appears to have no antiseptic properties. It is to be recommended for use in clean corneal ulcers, especially when deep, in descemetoceles, and in cases of small iris prolapse or when fistulæ are left behind.

Willis O. Nance (*Therapeutic Gazette*, Aug. 15, 1912) has used this treatment almost daily, and says his later experience has justified his belief that in this remedy we have a safe therapeutic agent of value. Scarlet red has a useful and valuable place in ocular therapy. Its especial effect in corneal diseases is to incite and accelerate regeneration of stroma, thereby encouraging the process of cicatrization. Cases of ulcer of the cornea treated with scarlet red assuredly heal quicker than those in which it is not used. The author uses scarlet red ointment made by Parke, Davis & Co., and has noticed no irritation of the eye following its use.

J. Allen (*Therap. Gaz.*, Jan. 13, 1913) speaks very highly of scarlet red as a result of his experiences during the past eighteen months. He found the ointment of value in corneal abrasions with or without actual ulceration; also, in other eye injuries, such as wounds of the cornea, abrasions and wounds of the conjunctiva. He recommends the remedy in corneal ulcers and gives examples of obstinate cases of this sort, with sloughing and hypopyon, in which excellent results were achieved.

The ointment used in eye cases, is one per cent. scarlet red in vaselin, or vaselin and lanolin equal parts. It is freshly prepared for each case. A minute portion is placed on the conjunctival surface of the everted lower lid; then a pad is applied to the eye and secured with a bandage. This is repeated once daily or every other day. The use of atropin or other remedies must be carried out if indicated; the scarlet red is an accessory treatment. A little irritation was noted in a few of the many instances in which the remedy was used, but none of the patients complained of pain or marked discomfort.

Lewin (*Oph. Year-Book*, p. 37, 1914) discusses the action of amidoazotoluol on the eye. This preparation is chemically related to scarlet red, which is a compound of amidoazotoluol with beta naphthol. Defects of the superficial layers of the cornea, artificially produced in rabbits, healed more rapidly when brought under the action of amidoazotoluol, and the resulting corneal scars appeared more transparent. As the preparation has no antiseptic action, Lewin recommends that it should only be used after cleansing of the ulcer. She employed the drug successfully fourteen times in corneal ulcer with threatened rupture, in the form of a 3 per cent. salve in association

with pilocarpin. It also gave excellent service after removal of a corneal tumor and after plastic operations on the lids and conjunctiva. In seven cases of symblepharon and ankyloblepharon the adhesions with the eyeball were simply divided; after which, under treatment with amidoazotoluol salve, the conjunctival sac was reestablished in from three to five days.

J. Ohm (*Zeitschr. f. Augenheilk.*, Jan., 1915) found scarlet red ointment useful in preventing ulcers of the cornea after the Heisrath-Kuhnt operation for trachoma, as well as in curing infiltrated ulcers in trachomatous subjects. The prescription is: Scarlet red (Michaelis), 0.5; Olive oil rubbed down with pure white American vaseline, 10.0.

Scarpa, Antonio. One of the greatest anatomists, surgeons and ophthalmologists of all time, whose name is commemorated in the expression, "Scarpa's triangle." Born in Italy May 19, 1752, he received his medical degree at Padua when only 18 years of age. In 1772, at the early age of 20, he was elected full professor of anatomy and theoretical surgery at the University of Modena. At his instigation, Duke Franz III, caused to be constructed the Modena Anatomical Institute. In 1783, on the invitation of Emperor Joseph II, he was called to the chair of anatomy at the University of Pavia. For many years he was Director of the Medical Faculty at the same institution. He died at Pavia Oct. 31, 1832.

The importance of Scarpa for medicine and surgery in general, can hardly be overestimated. The first to describe "Scarpa's triangle," he also discovered the naso-palatine nerve, as well as the "true posterior staphyloma of Scarpa," and wrote the greatest work on ophthalmology that had appeared until his time. In this memorable book, the distinguishing features are, a clear and almost brilliant literary style, greatly bettered definitions of ophthalmologic technicalities, and a well-marked tendency to the practical application of the then known pathology and optics. The book (No. 4 below) was a high authority in a number of countries for many years.

Scarpa's most important writings are as follows: 1. *Anatomicarum Annotationum Lib. I et II* (2 vols., Modena and Pavia, 1779, 85; 2d ed., Pavia and Milan, 1792.) 2. *Anat. Disquisitiones de Auditu et Olfactu.* (Pavia and Milan, 1789.) 3. *De Penitiori Ossium Structura Commentarius.* (Piacenza, 1800; 2d ed., Leipsic, 1799; Ger. trans., Leipsic, 1800; Eng. trans., London, 1830.) 4. *Saggio di Osservazioni ed Esperienze sulle Principali Malattie degli Occhi.* (Pavia, 1801; later eds., 1805, 1811, 1817, 1836; Ger. trans., Leipsic, 1803, 2d ed. 1823; Eng. trans., London, 1806, 2d ed., 1818; French trans., Paris,

1802, 2d ed. 1807, 3d ed. 1811 and a French elaboration by Fournier-Pescay and Bégin, Paris, 1839; Dutch trans., Groningen, 1812.) 5. *Sull 'Aneurisma. Riflessioni ed Osservazioni Anat.-Chirurgiche.* (Pavia, 1804; numerous later eds. and translations.) 6. *Mem. sulla Legatura delle Principali Arterie degli Arti, con una Appendice sull' Opera dell' Aneurisma.* (Pavia, 1817; Ger. trans., Berlin, 1821; French trans., 1822.) 7. *Mem. sull' Ernie del Perineo.* (Pavia, 1821).—(T. H. S.)

Schacher, Polycarp Gottlieb. A celebrated German anatomist and surgeon, who first described the ophthalmic ganglion, and who first proved, by means of an artificial, or schematic, eye, that opacities in the vitreous might be the cause of the so-called *muscæ volitantes.* In addition to an excellent work on anatomy, he wrote "*De Cataracta*" (Leipsic, 1701).—(T. H. S.)

Schädel. (G.) Cranium.

Schaeffer, Johann Gottlieb. A celebrated German physician who paid considerable attention to ophthalmology. Born Sept. 13, 1720, at Querfurt, Saxony, younger brother of the celebrated scientist, Jakob Christian Schaeffer, he was for a time an apothecary. Turning his attention to medicine, he received his degree at Altdorf in 1745. Having held a number of high official positions, he died at Ratisbon Feb. 1, 1795.

His only ophthalmologic writing was entitled "*Geschichte des Grauen Staares und der Neuen Operation, solchen durch Herausnehmung der Krystallinse zu Heilen*" (1764).—(T. H. S.)

Scharlach. (G.) Scarlet.

Scharlach red. See **Scarlet red.**

Scharlachsehen. (G.)) Red vision.

Schattenprobe. (G.) Skiascopy.

Schaudinn's bacillus. The spirocheta pallida.

Schauenburg, Karl Hermann. A German physician, who devoted much attention to ophthalmology. Born at Bünde, near Herford, Westphalia, Apr. 23, 1819, he received his medical degree at Berlin in 1843. He practised in many places: Herford, Schildesche near Bielefeld, Brodenbach near Coblenz, Düsseldorrf, Quedlinburg, and elsewhere. He was an excellent operator on the eye, incidentally a poet and dramatist of no mean ability. He died at Moers Oct. 21, 1876. His chief ophthalmologic writings are: 1. *Das Accommodationsvermögen der Augen.* Nach A. Cramer und Donders. (Lahr, 1854). 2. *Ophthalmiatrik.* (*Ib.*, 1856). 3. *Der Augenspiegel, nebst Beiträgen zur Diagnostik innerer Augenkrankheiten.* (*Ib.*, 1854; 5th ed., 1873).—(T. H. S.)

Schere. (G.) Scissors.

Scheide. (G.) Sheath.

Scheidewand. (G.) Septum.

Scheinbar. (G.) Apparent.

Scheinbarer Brennpunkt. (G.) Virtual focus.

Scheiner, Christoph. More commonly called "Pater" Scheiner. Born in 1575 at Walde, near Mindelheim in Swabia, he entered the order of Jesuits in 1595, became professor of Hebrew and Mathematics, first at Freiburg later at Ingolstadt, taught for a number of years at Rome, and finally became Confessor to the Grand Duke at Neisse in Schlesien, where he died July 18, 1650.

For the numerous and important services of Scheiner in the field of optics, see **Ophthalmology, History of.**—(T. H. S.)

Scheiner's experiment. An experiment for proving that the eye cannot accommodate for a near and a distant object at the same time. It consists in fixing the gaze upon a small object, and then looking beyond it at some distant point. The image of the former then appears to be double and blurred. See, also, under **Diplopia,** p. 4006, Vol. VI of this *Encyclopedia*, as well as **Scheiner, Christoph.**

Schelhammer, Christopher (1620-1652). Uncle of the celebrated Rolfinck, who, for the first time in history, demonstrated by actual dissection the true location of cataract. It was really in order either to confirm or to refute the theoretical teaching of Quarré (that the site of cataract is in the crystalline lens) that Rolfinck undertook his now immortal dissections. And Rolfinck came to know of the Quarrian doctrine by means of a letter which he received from this maternal uncle, Schelhammer. Otherwise than for this fact, Schelhammer is of no ophthalmological importance.—(T. H. S.)

Schell, Henry S. A prominent American ophthalmologist and oto-laryngologist. Born at Philadelphia, June 1, 1835, he received his medical degree of the University of Pennsylvania in 1857. For the next three years he practised general medicine in Philadelphia. From 1860-'69 he was assistant surgeon in the regular army. Retiring to private life, he settled as ophthalmologist and oto-laryngologist in Philadelphia, where he lived until his death. He died of chronic nephritis, at San Diego, Calif., Mar. 15, 1890.

Schell was a rather prolific writer. Among his more important ophthalmologic articles, we may mention: 1. Iritis. (*Phila. Med. Times*, 1874). 2. Hemiopia. (*Med. and Surg. Reporter*, Aug., 1876). 3. Glaucoma. (*Ibid.*, Nov., 1876).—(T. H. S.)

Schematic eye. The *reduced eye* of Donders. It is supposed to contain only one refracting medium, whose index of refraction is to

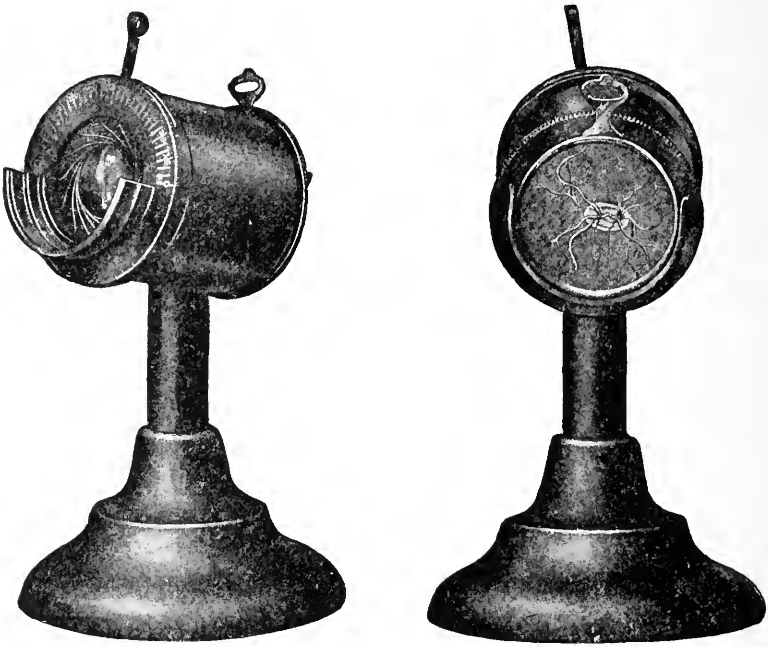
that of air as 4 to 3, and to have only one refracting surface, the cornea. The radius of curvature of the cornea is 5 mm., and its center of curvature coincides with the optical center of the eye. The length of the eye from cornea to posterior pole is 20 mm. *Listing's schematic eye* is a diagrammatic eye constructed by Listing for the

De Zeng Schematic Eye.

more exact calculation of the rays of light through the eye. It has six cardinal points, corresponding to those of optical lenses and situated on the optic axis, viz., two foci, two principal points, and two nodal points. According to Listing, the first or anterior focus lies 12.8326 mm. in front of the cornea, and the second or posterior focus lies 14.6470 mm. behind the posterior surface of the lens; the first principal point lies 2.1746 mm., and the second principal point 2.5724 mm., behind the anterior surface of the cornea; the first nodal point lies 0.7580 mm., and the second nodal point 0.3602 mm., in front of

the posterior surface of the lens. See also **Reduced eye**; and **Ryland schematic eye**; as well as the first chapter under **Refraction and accommodation of the eye.**

There are several so-called schematic eyes on the market. Of these the De Zeng-Standard Co., lists three. One of these has a variable pupil attachment, with openings of 1½-3-5-7 and 10 m-m, so placed as to reproduce the exact anatomical position of the iris within the



Fisher's Schematic Eye.

living eye. It may be tilted to any angle desired and is accurately graduated for the varying degrees of ametropia. It contains the normal fundus in full color, mounted radial with the dioptric center of the eye. The lens is ground to eliminate corneal reflexes and is held by metal fastenings. The eye is made of metal throughout and has a double front cell for holding two lenses.

Another is the same as the foregoing except that it is mounted on a short stationary base and does not contain the variable pupil or tilting attachments.

Still another has the variable pupil attachment but is mounted on a short stationary base and does not contain the tilting attachment.

W. A. Fisher (*Ophthalm. Record*, March, 1907) prefers his schematic eye to all others in the market because of its iris diaphragm, its 24 pictures of normal and abnormal fundi, and its accompanying explanatory chart. Each picture is on a slide; each represents a different condition and is easily changed. When the student becomes proficient with a large pupil he can gradually reduce its diameter until he gets the pinhole size; by this time he has also learned to regulate his light and to use the ophthalmoscope on the dilated pupils of patients.

The Ryland schematic eye (see **Ryland**) was designed to meet the need for a schematic eye which would closely approach the dimensions and conditions of the human eye.

As shown (under **Ryland**) the principal parts are the four globes and the stand. These globes represent four standard refractive conditions: emmetropia, hypermetropia, myopia, and astigmatism. The first three conditions are obtained by differences in the anterio-posterior length of the globe, the corneal radius for each case being the same, that is, 8 mm. The last condition is obtained by the use of a toric cornea. The retinal surface of each globe is slightly frosted, this gives a realistic appearance to the artificial retina placed in contact with the globe. An iris diaphragm in contact with the cornea provides for various pupillary diameters, while by not closing the retinal end of the stand tube, the images of objects formed on the retinal surface of the globe can be observed. This schematic eye is available for the demonstration and study, under conditions closely approaching those of the human eye, of ophthalmoscopy, keratometry, retinoscopy, and ophthalmometry; further, the changes in the size and definition of the retinal image during examination may be observed.

Schenkl's test (for feigned blindness). See p. 1187, Vol. II., of this *Encyclopedia.*

Scheroma. (L.) An old term for dryness of the eye from want of lachrymal secretion.

Schiascopia. (It.) Retinoscopy.

Schichtstaar. (G.) Lamellar cataract.

Schick test. This procedure for the diagnosis of immunity to diphtheria, offers a method of separating persons likely to be attacked by diphtheria from non-susceptible individuals. One-fiftieth of the minimum lethal dose of toxin for guinea-pigs is injected intradermally, and if antitoxin is absent, or present in such small amounts as to be insufficient for protection of the individual, a positive reaction evidenced by a circumscribed area of redness and infiltration appears in twenty-four to forty-eight hours. When this amount of toxin is in-

jected intradermally it is, according to Schick, necessary that at least 1-30 of a unit of antitoxin to each cubic centimeter of blood be present in order to prevent the appearance of a reaction. All exposed persons who give a positive reaction should be immunized with antitoxin.

See **Diphtheria,** p. 3398, Vol. VI of this *Encyclopedia.*

Schielen. (G.) Strabismus.

Schiferli, Rudolph Abraham. A celebrated 18th century Swiss obstetrician and surgeon, who devoted much attention to ophthalmology. Born at Thun, Switzerland, in 1773, he received his professional degree at Jena in 1796, presenting as dissertation "De Cataracta." After a brief period of graduate study in Paris, he became Chief Field Surgeon in the Swiss Army, a position which he held throughout the war with Austria. After he had held a number of other state and military positions, he was appointed in 1805 professor of surgery and obstetrics at Bern. Late in life he retired to Elfenau, where he died June 3, 1837.—(T. H. S.)

Schillerization. A peculiarity in the structure of some crystalline bodies which causes them to shine with a metallic lustre when turned in different directions.

Schindler, Heinrich Bruno. A distinguished German surgeon and ophthalmologist, grandson of Heinrich Wilhelm S. and son of Heinrich Traugott Schindler. Born at Greiffenberg, in Silesia, Aug. 22, 1797, he studied at Dresden and Breslau, receiving his professional degree at the last-named institution in 1819. His dissertation, on this occasion, was "De Iritide Chronica, ex Keratonyxide Orta." Even before his graduation he had become assistant at the Breslaú surgical clinic. Settling in his native town, he became a famous operator, especially on the eye. In his latter years he was Sanitary Councillor and President of the Society of Physicians of Silesia. He died Oct. 27, 1859. Among his writings, which are very valuable, the following should be especially noted: 1. Ueber Entzündung der Kapsel der Wässrigen Feuchtig-Keit, über Iritis Chronica als Folge der Keratonyxis und über die Kapsel selbst. (*Langenbecks Neue Bibl. f. Chir. und Augenh.* II, p. 401-417, 1819). 2. Neurologisch-therapeutische Ophthalmologische Andeutungen. (*v. Graefes und v. Walthers J. der Chir. u. Aug.*, XII, p. 165-271, 1828). 3. *Reminiscenzen aus der Praxis der Augenkrankheiten.* (1832). 4. Die Entzündungs-Formen der Menschlichen Hornhaut. (*Ammons Monats-Schr.*, 1838). 5. Zur Lehre von den Traumatischen Augen-Entzündungen (*Ammon's Zeitschr. f. Ophthalm.*, V, p. 54-72, 1837). 6. Die Neuesten Richtungen in der Augenheilkunde. (*Ammons Monats-Schr.*, II, p. 111,

1839). 7. Resorptio Cataractae Spontanea. (*Ammons Zeitschr. f. Ophthalm.*, V, 1837). 8. *Die Lehre von den Unblutigen Operationen, Ahaematurgia.* (2 Vols., Leipsic, 1844).—(T. H. S.)

Schiötz's tonometer. See **Tonometer** as well as **Glaucoma,** and p. 4633, Vol. VI of this *Encyclopedia.*

Schirmer, Rudolph. A prominent German ophthalmologist. Born at Greifswald, Germany, March 10, 1831, he received his medical degree at the Greifswald University in 1856. After a "Wanderjahr" at Göttingen, Berlin, Paris, and Vienna, he returned to Greifswald, where he settled as ophthalmologist. In 1860 he became the first teacher of ophthalmology in Greifswald. Seven years later, his chair was made an extraordinary professorship, and in 1873 an ordinary one. He was also Director of the University Hospital for Eye Diseases. He died Jan. 27, 1896.

Schirmer was an operator of great skill, but not a prolific writer. Among his compositions, however, we may mention "*Die Lehre von den Refractions-und Accomodations-Störungen des Auges*" (Berlin, 1866) and "Die Krankheiten der Thränenorgane" (*Graefe-Saemisch Handbuch der ges. Augenheilkunde*, 1st ed.)—(T. H. S.)

Schistoscope. A polariscope used for the formation of complementary colors.

Brücke's schistoscope is a form of colorimeter in which the varieties of color are obtained by interference. A cleavage plate of mica is placed between a polarizing nicol and a Rochon prism. For a detailed description, see *Poggend. Annal.* 74, 582, 1849.

Schizoblepharia. (L.) An ancient name for coloboma of the lid.

Schlagader. (G.) Artery.

Schlagintweit, Wilhelm August Joseph. A well-known German ophthalmologist. Born Dec. 8, 1792, at Regen, Germany, he received his medical degree at Landshut in 1816, presenting as dissertation "De Cataractarum Origine." Devoting himself almost exclusively to ophthalmology, he settled in Munich and became a renowned operator. In May, 1822, he founded in Munich a private infirmary for eye-diseases, of which he was the first superintendent, and in which, although an institution of sixteen beds in 1852, much excellent work was done. He had five sons, all of whom became distinguished either as travellers or as scientists. He died Aug. 11, 1854. His ophthalmologic writings are: 1. *Ueber den Gegenwärtigen Zustand der Künstlichen Pupillenbildung in Deutschland.* (Munich, 1818). 2. Erfahrungen über mein Iriankistron. (*Rusts Mag.*, 1820, VIII). 3. *Jahresberichte über die Privatheilanstalt für Augenkranke.* (Munich, 1822-1854).—(T. H. S.)

Schlangengift. (G.) Snake poison.

Schlauch. (G.) Canal; follicle.

Schleich's infiltration anesthesia. See p. 443, Vol. I of this *Encyclopedia.*

Schleim. (G.) Mucus.

Schleimhaut. (G.) Mucous membrane.

Schlemm's canal. See p. 1378, Vol. II of this *Encyclopedia.*

Schliesser der Augenlider. (G.) Orbicularis palpebrarum muscle.

Schlösser's magnet. This instrument is described on p. 4255, Vol. VI of this *Encyclopedia.*

Schmarotzer. (G.) Parasite.

Schmidt, Johann Adam. A famous anatomist, surgeon and ophthalmologist of Vienna, who invented the term "iritis," and did much to advance our knowledge of that disease. He also wrote extensively on the various affections of the lachrymal apparatus. Born at Aub, near Würzburg, Germany, Oct. 12, 1759, he was apprenticed in his fourteenth year, very much against his will, to a private instructor in anatomy and surgery. Afterwards, however, he learned to love the medical profession, and became an enthusiast in everything connected with the art of healing. In his eighteenth year he ran away, and joined, as assistant surgeon, the Austrian regiment of the Grand Duke Charles. In 1779 he was stationed in the garrison at Vienna, and, while in that city, he studied anatomy with Barth, surgery with Leber, and internal medicine with Stoll. Under all these teachers he was an earnest and capable student.

In 1780 Schmidt was appointed clerk to the Sanitary Division of the army, in which position he remained for more than five years.

On August 11, 1788, he became extraordinary instructor in anatomy and surgery and prosector at the Joseph's Academy in Vienna. In 1789 he received his medical degree.

In the very same year it was (1789) that the Emperor Joseph II, instructed Barth (q. v.) to educate two young physicians as specialists in ophthalmology, there being at the time, in addition to Barth, no expert on this subject throughout the whole of his domains. Barth was given the privilege of selecting the physicians, either from within or from without the Austrian Empire. He was also granted a yearly allowance of a thousand guldens for the maintenance and education of these ophthalmologic students.

Barth chose his prosector, Ehrenritter (q. v.) and Schmidt, the subject of this sketch.

The following passages, which we translate from the writings of Schmidt, *via* Hirschberg, afford much interesting information in con-

nection with this matter: "From the *'Prelectiones de Morbis Oculorum'* (A. D. 1801) p. 8: 'A similar contract Emperor Joseph closed with Barth, if he were willing to train Schmidt. Schmidt was, at that time, prosector and extraordinary instructor in anatomy, and had moreover already performed all the other [i. e., non-ophthalmic] surgical operations, nevertheless his instruction continued for four years. In the first year he merely watched his teacher operate, and was also instructed by him concerning the different kinds of cataract. During the second year, he had, in addition, to practice continually on dead eyes, then was obliged to undertake the operation on various living creatures, by possible evil results on the eyes of which he could produce no serious losses; in the third year he operated, under the observation of his instructor, at the very first occasion, on twelve cataractous patients in the general hospital, but so unfortunately that only three could see. Barth would have been successful with at least eight out of the dozen. Five of the patients were forever robbed even of the hope of a successful later operation. The result of these disasters well-nigh caused Schmidt to lose his own hope that he might ever attain to the necessary skill for this division of the art of surgery. Barth's exortation, however, put him on his feet again, and only at the end of four years, when, if Barth was to be discharged of his contract, Schmidt must operate before a committee of physicians on twelve cataract patients, and on six of them successfully, could the student, Schmidt, pass successfully through the necessary ordeal. From this time forward, Schmidt was left to his own resources, observed, thought for himself, and in fact succeeded in shaping himself into what he is today.' "

At this point, Hirschberg very appropriately remarks, "Either Barth was a bad, even a self-seeking, instructor, or Schmidt was a student with very slight ability for ophthalmic operations—or both."

In 1802—just one year later—Schmidt holds the following language in his "Ansicht der Ophthalmonosologie und Ophthalmiatrik als Theorie und Kunst im Jahre 1801" (*Ophth. Bibl. von Himly und Schmidt*, I, 2, p. 43 ff.): "I was already public instructor in anatomy and surgery at the Joseph's Academy in Vienna, and for several years a practicing physician and surgeon, I was also well experienced in writing of various kinds, when, in 1789, as Professor Barth was inclined to give up both his professorial chair and his practice, I was ordered, together with Barth's prosector, Ehrenritter, by the late Kaiser Joseph II, to accept from Barth a special training for that branch of ophthalmology. Barth occupied himself with our training continually for two years, and we were obliged at the end of the two

years to operate publicly before a committee of physicians and surgeons appointed by the court. As Barth, according to the report returned by the commission to the court, had discharged himself from his obligation, he soon thereafter returned to his present private life, and, in a few months, Ehrenritter died. From 1791 till 1802 I maintained in Vienna a private infirmary for eye-patients, treated in addition for several years in my dwelling and in the military hospital a large concourse of people, and operated often, not only in my infirmary but also in the Vienna General Hospital and in the Military Hospital. There will, therefore, seeing that I have practiced for fourteen years in one of the most populous cities of Europe, be few diseases of the eye which I have not had an opportunity to see. As I, from the very beginning, have been concerned to determine not the forms but the disease in the forms, so much the more may I lay claim to credibility for this, that I employed the entire period not in writing, but in observing and the acquiring of experience. I have, therefore, had time and opportunity to accumulate both observations and experiences."

In 1795 he was appointed full professor at the Josephinum, as well as Field-surgeon-in-chief of the armies in Austria and Italy. In 1801 he founded with Himly the *"Ophthalmologische Bibliothek,"* the first ophthalmologic journal in history. (See **Himly**.) In 1807 he received the honorary M. D. from the University of Würzburg. He died of typhoid fever Feb. 19, 1809.

Schmidt was a skilful operator and a brilliant lecturer. He was also, spite of his brusque exterior, a man of warm heart and almost unlimited charity. For sixteen years he supported at his own cost the private eye infirmary above-mentioned.

Aside from works of a general character, his most important writings are as follows: 1. *Ueber Nachstaar und Iritis nach Staar-Operationen.* (Wien, 1801). 2. *Ueber die Krankheiten des Thränen-Organs.* (Vienna, 1803). 3. *Ueber eine Neue Heilungsart der Augenliderlähmung und des Anhaltenden Augenlidkrampfes.* (*Abh. d. Josephs-Akad.*, II, p. 365, 1801). 4. *Prüfung der von Herrn D. Beer bekanntgemachten "Methode, den Grauen Staar sammt der Kapsel Auszuziehen."* (*J. f. d. Chir., Geburtsh. und Gerichtl. Arzneikunde.* III, 3, pp. 395-446, 1801). 5. *Praelectiones de Morbis Oculorum Professoris Adami de Schmidt.* Anno 1801. 6. Ansicht der Ophthalmonosologie und Ophthalmiatrik als Theorie und Kunst im Jahre 1801. (*Ophth. Bibl. von Himly u. Schmidt*, I, 2, 1802, pp. 1-66). 7. *Ueber Herrn D. Beer's Antwort zur Vertheidigung seiner Handgriffe,*

die Staar-Linse samt der Kapsel Auszuziehen. (Vienna, *J. f. d. Chir., Geb.,* etc. IV, pp. 17-26, 1802). 8. Ueber Pupillen-Bildung durch Einschneidung, Ausschneidung und Ablösung der Iris. (*Ophth. Bibl. von Schmidt u. Himly,* 1803, II, 1). 9. Beschreibung einer Merkwürdigen Abnormen Metamorphose des Augapfels. (*Ophth. Bibl.* II, 1, p. 54-72, 1803). 10. Reihen von Krankheitsformen, deren Substrat die Conjunctiva des Menschlichen Auges ist. (*Ophth. Bibl.,* III, 1, 1-74, 1805). 11. Augenlid-Tripper. (*Ophth. Bibl.,* III, 2, 107-192, 1806). 12. Des Herrn D. Beer, zu Wien, Antwort auf des Herrn Rath und Prof. Schmidt's Prüfung s. Methode, den Staar mit der Kapsel Auszuziehen. (*J. f. d. Chir., Geburtsh.,* etc., III, pp. 654-667, 1801). 13. Der erste Gelungene Versuch, den Ueberwiegenden Expansionstrieb der Iris, etc. (*Ophth. Bibl.,* III, 1, p. 178, 1805).—(T. H. S.)

Schmidt-Rimpler, Hermann. ("The suffix 'Rimpler' was not assumed till after his marriage.") A famous German ophthalmologist. Born at Berlin, Dec. 30, 1838, he studied at the Medico-Chirurgical Fried-

Hermann Schmidt-Rimpler.

erich Wilhelms Military Institute, and became, in 1863, chief of the clinic under Albrecht von Graefe. After a number of military expeditions, he was for a time staff physician at the Friedrich Wilhelms Institute, and again the first assistant to von Graefe.

In 1871 he was called to Marburg as professor extraordinary in ophthalmology, and director of the University Eye Clinic. In 1873 he was made full professor. He played a considerable part in local politics at Marburg, and, in fact, became vice-mayor of the city. In 1890 he was called as full professor of ophthalmology to Göttingen,

and, still later, to Halle. A call to Königsberg, however, he rejected. He retired from active work in 1910, and died Sept. 23, 1915, aged 77.

The full list of Schmidt-Rimpler's ophthalmic writings is very long. Suffice it here to mention: 1. Glaucom und Ophthalmomalacie. (Graefe-Saemisch *Handb.*, Leipsic, 1873). 2. *Augenheilkunde und Ophthalmoscopie.* (Braunschweig, 1884; 6 ed., 1894; trans. into English, Italian, and Russian). 3. *D. Erkrankungen des Auges im Zusammenhang mit anderen Krankheiten.* (Vienna, 1898). 4. *D. Schulkurzsichtigkeit u. ihre Bekämpfung.* (Leipsic, 1890). 5. *Ueber Blindsein.* (Breslau, 1882). Many of his articles occur in Graefe's *Archiv.*—(T. H. S.)

Schmidt-Rimpler's apparatus. This is a rather complicated and, from the American standpoint, impractical combination of an ophthalmoscope, illuminating lamp and a convex lens for determining the refraction of the human eye by means of the indirect method. It is fully described and illustrated in the inventor's *Lehrbuch der Augenheilkunde.*

Schmucker, Johann Leberecht. A widely known Prussian military physician of some importance ophthalmologically. Born in 1712, he studied in Berlin and Paris, became "General-Chirurgicus," and was extremely active in a medical and surgical capacity throughout the Seven Years' War. A keen observer and skilful operator, he was also a clear and forceful writer, and his *"Chirurgische Warnehmungen"* (Berlin and Stettin, 1774) and *"Vermischte Chirurgische Schriften"* (3 vols., Berlin, 1776-'82) constitute veritable mines of accurately observed and well-expressed experience. In the latter of these works, the author presents a highly valuable treatise on the cure of "Black Cataract."

Schmucker died Mar. 5, 1786.—(T. H. S.)

Schnabel, Isidor. A well known Austrian ophthalmologist, renowned especially for his studies in internal eye diseases. Born at Neubidschow, Bohemia, Nov. 14, 1842, he received his medical degree at Vienna in 1865. His graduation thesis was entitled "The Position and Size of the Upright Retinal Image." He was then for a time assistant to Jaeger, soon thereafter becoming privatdocent for ophthalmology at the University. In 1877 he was made professor ordinarius of ophthalmology at Innsbruck, and in 1887 was called to the like chair at Gratz, in 1892 at Prague, and, at length, in 1896, at Vienna, in succession to the great Stellwag. Dr. Schnabel died suddenly, while entering the hospital, on the morning of Dec. 4, 1908.

The following estimate of Schnabel is from Dr. Adolf Alt, of St. Louis: "The extreme acuteness of his critical mind for which delving in Kant's philosophical works formed a recreation after the day's labors, permitted him to recognize with ease the weak points in theoretical deductions, and often prompted him to make studies of his own. With this, he knew in a masterly way, to detail in short form and with extremely logical consequence the main symptoms of any condition. Whoever has read his little article on 'Two Cases of Strabismus' will be surprised at the apparent simplicity of the explanation and the power and force of the proofs. These peculiarities of his descriptions which reached their height in his papers published in the last two decades of his life, demand a not inconsiderable mental effort on the part of his readers, but also, afford him great enjoyment.

"As Schnabel mastered writing, so was he master in the art of speaking, and he was considered by far the best orator among the academic teachers of the faculty. The acuteness of the mind and of the criticism, the pregnancy of expression combined with a manner of expression complete in its form, his broad education and high idealism gave to his speech a captivating power. Whether he spoke at some festival as the orator, or as an academic teacher, or made a political speech, the eyes of his audience hung on his lips. His lectures were of a broad conception and he knew, without sacrificing details, how to bring before the hearer the character of the symptoms and their casual relations as a whole. His lectures, furthermore, were free from petty pedantry, although he put great store by a logically correct expression. This was the reason that as examiner he was sometimes held in awe, although he judged the knowledge of the candidates mildly. Nothing could offend him but neglectfulness, laziness of thought and untruthfulness, things which were alien to his innermost being, even directly opposed to it. In such cases his criticism from being sharp could change to being merciless. Such emotions, however, were the best proof of the high ideals which Schnabel thought of the duties of the academic citizens and of those physicians whose education he tried to further with the greatest zeal. A complete gentleman, he ostracized in the sharpest manner possible the mercantilism which here and there appears in medical circles. To his patients he was not alone a professional advisor, but also a benevolent friend, who paid the strictest attention to his duties. Therefore, he devoted nearly all his working faculties to his clinic. He never tired in examining patients, no case escaped his observations and thus he put his personal stamp on the whole clinical work.

"The strong sense of duty of which he was possessed, he also demanded of his assistants, and even a small omission could arouse words of severe reprimand. However, to whoever worked zealously toward the same ends which represented Schnabel's ideals, he was a friend on whom to count. Being wrapped in himself he made few words, yet his pupils felt that he was their friend. The independence of mind which Schnabel had preserved he, also, expected of his pupils; in their works they were not simply the supporters of his opinions, no, he never robbed them of the freedom of expressing their own thoughts, even if he did not agree with them. When asked for it, he was not niggardly with his advice and criticism, but always spared the pupil's mental independence.

"Like hardly anyone else, Schnabel united a retiring character with a winning amiability. Despising hollow exterialism he lived and worked quietly, unobtrusively, in a certain retirement from humanity in general and from his special colleagues. Thus he came personally forward but seldom, never attended a congress, spoke rarely in scientific societies, and then only when he had a new idea to report. As president of the Vienna Ophthalmological Society, his personality lent it the greatest weight, imbued it with life and kept the interest of its members astir, even if they did not share his opinions.

"Only in the last years Schnabel came forth from his retirement and in public took a decisive stand for his convictions. At the last elections for the Reichstag he fought with great force for the ideals which had made him a supporter of the free school. The uprightness of his character, the absolute truthfulness which showed in his words and acts were bound to win acknowledgment even from his antagonists. The integrity of his character, combined with rich mental gifts, with his broad knowledge and shining talent as an orator, stamped Schnabel as an uncommon personality, the all too early loss of which all must deplore."—(T. H. S.)

Schneeblindheit. (G.) Snowblindness.

Schneider, Eugen. A surgeon and professor of anatomy at Landshut, Germany, of a slight importance in ophthalmology because of his *"Das Ende der Nervenhaut im Menschlichen Auge"* (Munich, 1827). He was born in Tischenreuth, Upper Palatinate, Jan. 26, 1795, received his medical degree at Würzburg in 1820, and died April 9, 1874.—(T. H. S.)

Schneller, Moritz. A prominent German ophthalmologist. Born at Heinrichswalde, East Prussia, Jan. 31, 1834, he studied at Königsberg, Vienna and Berlin, receiving, however, his medical degree at

the first named institution in 1854. In 1855 he settled as ophthalmologist in Dantzig, where he soon was widely known as an operator. In 1855 he founded, with Nagel, a private eye infirmary, whose director he at once became, so remaining until his death. He was one of the first to understand the advantages of the ophthalmoscope, an instrument which he improved materially. He had peculiar views regarding specialism, the chief of which was that every specialist should remain throughout his life in general practice. He himself, in fact, lived up to this idea. His most important investigations were made in connection with medical ophthalmoscopy, heterophoria and the development of myopia in schools. His well known "test-letters" are extremely accurate, though not in common use. He was a man of kindly heart and great generosity. In consequence of the latter quality he died in debt. The date of his passing was Oct. 9, 1896, but the cause of his death could not be learned by the present writer. Schneller was survived by a wife and three children.—(T. H. S.)

Schöbl, Josef. A well known Bohemian ophthalmologist. Born at Pilsen, Aug. 16, 1837, he received his medical degree at Prague, and was for a time assistant to Hasner. Settling in Prague, he became in 1866 the Royal Bohemian oculist, and in 1883 the full professor of ophthalmology at Prague. He died April 6, 1902, aged 65.

Schöbl was a very prolific writer of journal articles, and in 1898 composed "Diseases of the Retina" for Norris and Oliver's *System of Diseases of the Eye*.—(T. H. S.)

Schoen, Johann Matthias Albrecht. A well-known German ophthalmologist and general practitioner. Born at Hamburg, Germany, Aug. 29, 1800, he studied at Halle and Berlin, at the latter institution receiving his degree in 1823. Returning to his native town, he taught and practised there until 1869, when, retiring from medicine absolutely, he removed to Stuttgart. There he died April 7, 1870.

Though he never was an ophthalmologist exclusively, yet the most of his practice and nearly all his publications concerned our special field.

The most important of his writings are: 1. *Handbuch der Pathologischen Anatomie des Auges.* (Hamburg, 1828). 2. Die Erweichung im Menschlichen Auge. (Hecker's *Annalen*, Bd. 16). 3. Einige Worte über die neu Empfohlene Keratoplastik. (Rust's *Magazin*, Bd. 23, 1826). 4. Ueber Kegelförmige Hervortreibung der Horhaut. (*Ib.*, Bd. 24, 1827). 5. *Anat. Untersuchungen von Zwei Kranken Menschlichen Augen.* (1829). 6. *Ueber Farbige Augengläser, bes. Bernsteinbrillen.* (1830). 7. Ueber die Eigentümliche Lage und

Bewegung des Auges bei Krankheiten. (Hecker's *Annalen,* 1830). 8. Ueber Marasmus Senilis der Kapsel und Linse. (Ammon's *Zeitschrift,* Bd. 1, 1831). 9. Zwei Fälle von Angeborener Atrophie des Augapfels. (*Ib.*) 10. Zur Geschichte des Epicanthus. (*Ib.,* Bd. 2, 1832). 11. *Nosologisch-therapeutische Darstellung der Gonorrhoischen Augenentzündung.* (Hamburg, 1834, p. 131). 12. Zur Pathologischen Anatomie des Augus. (Ammon's *Zeitschrift,* Bd. 4, 1835). 13. *Beiträge zur Praktischen Augenheilkunde.* (Hamburg, 1861).—(T. H. S.)

Schoenlein, Johann Lucas. A prominent German surgeon of moderate ophthalmologic importance. Born Nov. 30, 1793, at Bamberg, Germany, he studied at Landshut and Würzburg, at the latter institution receiving his degree in 1816. After certain scientific journeys and a period of practice at Bamberg, he qualified in 1817 as privatdocent in Würzburg in pathological anatomy. From 1820 till 1830 he was professor of special pathology and therapy and superintendent of the University Hospital. During this period he lectured on ophthalmology. He died in his native city of Bamberg, of exophthalmic goitre, Jan. 23, 1864.—(T. H. S.)

Schoenlein's disease. See **Purpura.**

Scholtz bacillus. This organism was obtained in Parinaud's conjunctivitis, is a Gram-negative bacillus with polar staining; non-motile, and can be grown in all ordinary media. See **Bacteriology of the eye.**

Schocl folliculosis. A name suggested by Greeff for the very common form of follicular conjunctivitis found in schools—especially when malhygienic conditions are present.

School hygiene, Ocular relations of. This subject has been pretty thoroughly discussed under the captions mentioned in **Hygiene of the eye,** p. 6089, Vol. VIII of this *Encyclopedia.* See, also, several of the subsections under **Care of the eyes,** especially on pp. 3187, 3204 and 3210, Vol. V of this *Encyclopedia.*

In addition reference is made here to other observations.

D. P. Macmillan (*Ill. Med. Journ.,* April, 1912) Director of the Department of Child Study and Educational Research, Chicago Public Schools, has studied binocular differences in the *visual acuity of school children* in the Chicago elementary and high schools, noting not only the fact of visual subnormality, but also the degrees of departure from normal vision. From a minute examination of 4,765 school children, ranging in age from 6 to 18 years—from entrance in the elementary school to graduation from high school—35 per cent. of the number showed some degree of visual imperfection. Defects

attained their maximum at ages 9, 10 and 11 years, or the fourth, fifth and sixth years of school life. The minimum number having imperfect vision appears at the thirteenth or fourteenth year of life. This improvement in certain years indicated by the number who give evidences of imperfection, is a further index of the intimate relation between improvement in vision and increased rate of general physical growth or power of resistance. The number of pupils in the four years of high school life, for the fifteenth, sixteenth, seventeenth and

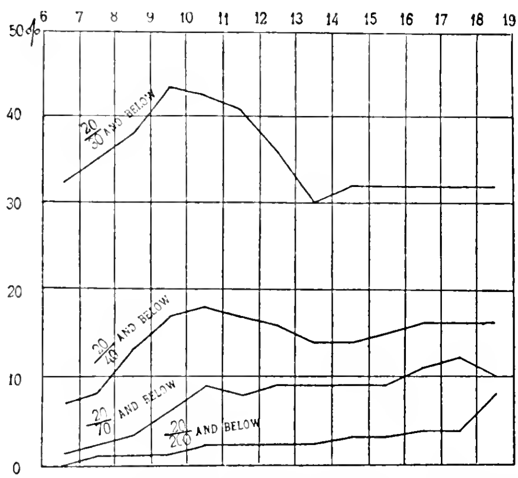


Chart 1.—School Life and Sight, showing the Per Cent. Defective in Visual Acuity for each Year.

eighteenth years, is the same as that which obtains at the age of 6 years, viz., 32 per cent.

Moreover, these very same years of school life, showing the greatest and the least number of pupils who are unable to see perfectly, are almost exactly the same periods giving evidence of a greater degree of visual defect; that is, almost the same time of school life which shows the greatest number of pupils who cannot see two-thirds as well as normal, indicates also the maximum number that cannot see one-half normal vision, and likewise the same is true for those seeing two-sevenths and again one-tenth normal vision.

Furthermore, in order to indicate that poor vision is in point of fact a determining factor in inducing backwardness in school studies, or at least, one of the very important indices of general physical subnormality, the writer exhibits Chart II, which shows the relative degree of

visual acuity of those pupils, at or above school grade, those below school grade at least two years, and those pupils three or more years below for their age, or the residents of the John Worthy school, boys commmitted on account of petty crimes and misdemeanors, to the City Juvenile reformatory. The charted record of these, some 5,000 cases, speaks for itself and requires no further explanation.

This will serve to raise for us the question, what is meant by poor vision from the point of view of school-room efficiency? It is a well-

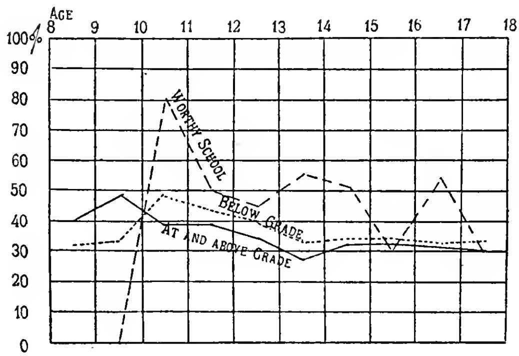


Chart 2.—Defective Vision and School Standing.

known fact that poor vision may be evidenced by the appearance of the pupils' eyes, by the pain and discomfort which they give, by the secondary or indirect influence on the general health, and by the actually determined inability to see perfectly; but it is not so often emphasized that differences exist in the visual acuity of each eye taken singly, and that herein lies at least one of the great sources of discomfort or danger and one of the most striking signs that every legitimate effort should be made for the conservation of the vision of pupils.

Macmillan has taken at random from the records of the visual acuity of 1,436 pupils from good American homes, ranging in age from 9 years to 14 years, in such a way as to show the differences in the power of each eye taken singly.

TABLE 1.—SHOWING THE DISTRIBUTION OF NORMAL CHILDREN FROM THE POINT OF VIEW OF THE VISUAL ACUITY OF EACH EYE TAKEN SINGLY.

HEARING CHILDREN.

Vision.	1.00 or better. Normal.	0.67 of normal. 20/30.	0.50 of normal. 20/40.	0.40 of normal. 20/50.	0.29 of normal. 20/70 or less.	Blind or nearly so.
The vision of both eyes being............	972	82	11	27	69	0
The vision of one eye being 1.00, the other	...	119	8	11	21	4
The vision of one eye being 0.67, the other	...	...	31	18	20	1
The vision of one eye being 0.50, the other	...	...	...	11	7	0
The vision of one eye being 0.29, the other	...	...	...	...	24	0
Total number examined, 1,436.						

These data presented in Table 1 are further supplemented by a compilation of the records of visual acuity of 500 girls, graduates either of Chicago high schools or of Chicago Teachers' College, ranging in age from 16 to 21 years, and be it added these cases are not specially selected but taken at random from the files of the writer's office.

TABLE 2.—VISUAL ACUITY OF GIRLS, AGED 16 TO 21 YEARS. FIVE HUNDRED HIGH SCHOOL OR NORMAL SCHOOL GRADUATES, TAKEN AT RANDOM.

Vision.	1.00	2/3 normal. .67	1/2 normal. .50	2/5 normal. .40	2/7 normal .29	1/5 normal or less
Vision of both eyes being...............	388	26	10	3	4	2
Vision of one eye being 1.00, the other..	...	26	2	6	6	8
Vision of one eye being .67, the other...	...	...	4	2	3	1
Vision of one eye being .50, the other...	...	...	...	6	0	3
Vision of one eye being .29, the other...	...	...	...	...	0	0
Per cent. of total.................	77.6	10.4	3.2	3.4	2.6	2.8

An editorial writer (*London Lancet*, Sept. 19, 1909) points out that "where education is compulsory, the proper regard for hygienic conditions under which it is carried out becomes a duty which can no longer be ignored." He also says that the ophthalmic hospitals and departments in London are being flooded by refraction cases from the County Council schools. In the same journal a correspondent reports on the eyesight of children attending army schools in India. He tells of three children, working at the same desk, stooping over their books, writing with their eyes 2½ inches from the page. The

eldest of the three was highly myopic, and the others were imitating him. In these schools myopia was noted in only 2 per cent. of the pupils; 16 per cent. had defective sight. Of 113 children examined by Place, at Deadham, near Boston, 21 were found wearing properly fitted glasses, 16 wearing improper glasses, and 47 more were recommended to wear glasses; only 29 did not need them. Among those improperly fitted were three hyperopes wearing concave lenses fitted by opticians. In Brussels, de Ridder found the percentage of myopes began at 5.5 per cent. between 6 and 8 years, and rose steadily to 18 per cent. between 13 and 14 years; but there was no decided change in the percentage of hyperopic or astigmic eyes. At the college of Perpignam, Espinouze found the percentage of myopia rose steadily from 9 to 19 years of age, while the percentage of astigmia remained the same.

Bradburne (*Oph. Year-Book*, p. 28, 1909) urges that in examining the eyes of school children the shadow-test should be employed, since it would reveal both the eyes that were myopic and those that were likely to become myopic. Carhart urges that sewing and weaving exercises should be limited, if not absolutely eliminated, from the kindergarten; that prolonged, close work should not be allowed before the age of 10; that young children should not be allowed to compete for prizes; there should be no grading in the primary schools, and that apparent laziness or inability to concentrate the mental attention, or deficient powers of observation, should lead to careful examination of the eyes. Pechin and Ducroquet advise the testing of school children by teachers or principals at the beginning of each school year. Karl discusses the duties of school physician and school oculist.

In the government school in *Egypt it is not ametropia, but trachoma*, that presents the most serious problem in hygiene. MacCallan reports that of 485 pupils examined at the beginning of the school year, 464, 95.2 per cent., were infected with trachoma. It is also noted that of those in the second or most severe state of the disease the number diminished from year to year. Of the children who were treated, 130 improved, 19 did not. Of those untreated, 39 improved, 270 did not. The most urgent problem is to bring the children under efficient treatment for this disease.

In London, where special metropolitan ophthalmic schools were esblished in 1903 other contagious ophthalmias than trachoma furnish the larger part of the patients. Thus of 502 children admitted in the year, but 82 were suffering from trachoma. Of the first 100 children admitted to the schools the average period of treatment was

18 months; of the last 100 the average was 7.4 months. Even for trachoma the duration of treatment had been lowered from 32 months to 17.7 months. In Messina 4 per cent. of the school children were found to be suffering from trachoma, and of these two-thirds came from families in which the disease prevailed. In another part of Sicily (Syracuse) 11 per cent. of the children had trachoma.

Clark states the faulty illumination in rural schools is responsible for much of the impaired vision encountered. Measurement of the desk illumination of an eight-room school, on a cloudy day, showed that more than half of the desks in some class rooms was less than one-third of the lowest minimum standard. The effect of such faulty illumination is to promote eyestrain and increase nearsightedness. The illumination of these class rooms could have been doubled by the proper tinting of reflecting surfaces; but the school authorities were without competent advice in this important detail of school construction. The need of such advice is largely responsible for many of the undesirable features of rural school life.

Ferree and Rand, as a result of their experiments, conclude: If light is well distributed in the field of vision and diffuse, and there are no extremes of surface brightness, the eye, so far as the problem of lighting is concerned, is practically independent of intensity. When proper distribution effects are obtained, intensities high enough to give the maximum discrimination of detail may be employed without causing appreciable damage or discomfort to the eye. See **Illumination,** p. 6152, Vol. VIII of this *Encyclopedia*.

For the control of distribution effects their results show that too much light is being used in ordinary work for the comfort and welfare of the eye. With semidirect reflectors means have not been found of producing the amount of light without introducing harmful brilliancies into the field of vision.

The angle at which the light falls on the object viewed is an import factor, but not nearly so important as evenness of surface brightness in the field of vision. Extremes of surface brightness in the field of vision seem to be the most important cause of the eye's discomfort and loss of efficiency in present lighting systems. In lighting from exposed sources it is not infrequent to find the brightest surface from one million to two and one-half million times as brilliant as the darkest; and from three hundred thousand to six hundred thousand times as brilliant as the reading page. These extremes of brightness in the field of vision are very fatiguing to the eye.

Of the systems of artificial lighting tested the best results have been obtained from the indirect systems, and the semi-indirect systems with

reflectors having a high density. By means of these reflectors the light is well distributed in the field of vision, and extremes of surface brilliancy are kept within the limits which the eyes are prepared to stand. Great loss of efficiency results from the use of semi-indirect reflectors of low and medium density, and of direct reflectors of shallow and medium depth. With direct reflectors of medium depth the best results have been gotten with reflectors of medium density. The opening need not have such a high brilliancy, and there is little contrast between it and its surroundings.

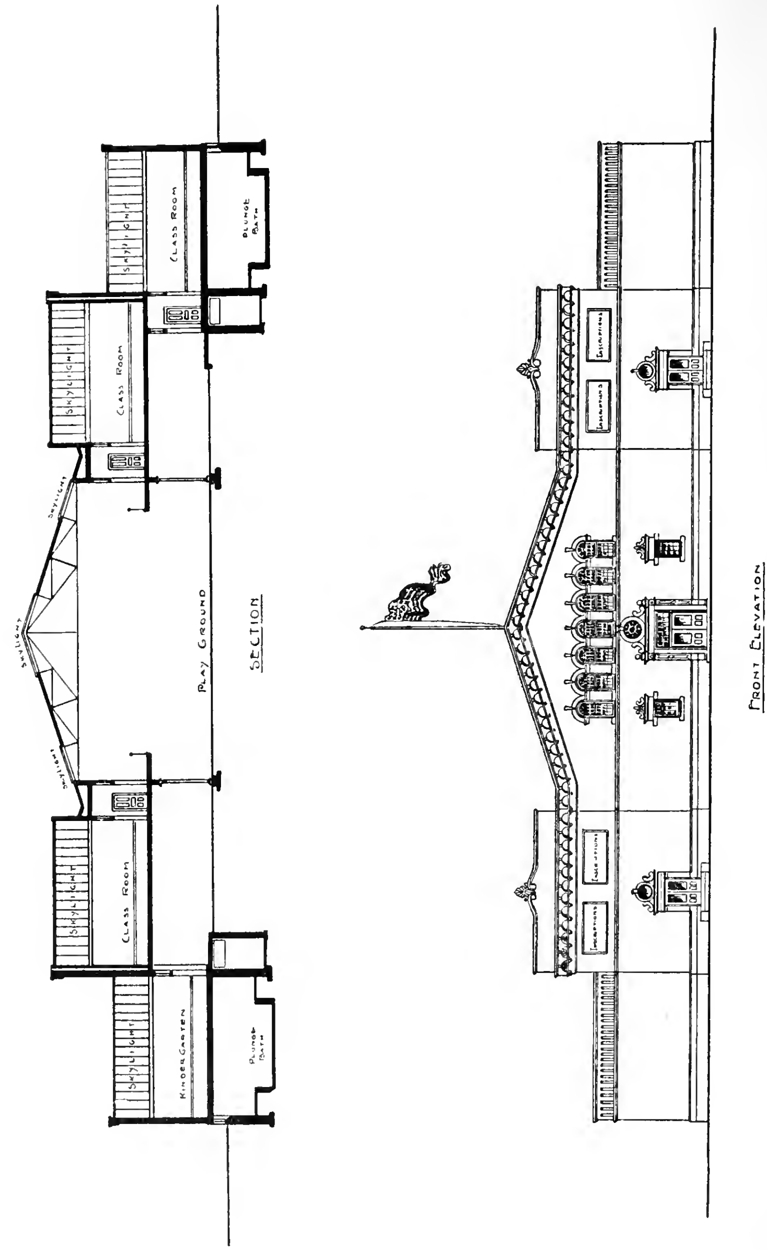
For the indirect reflector, the height should be so adjusted as to give as nearly as possible an even distribution of surface brightness on the ceiling and evenness of illumination on the working plane. In rooms of the height ordinarily found in dwelling houses, if the distance of semidirect reflectors from the ceiling is made great enough to produce these effects, the bright reflectors are dropped too low in the field of vision for the highest comfort and efficiency of the eye. The denser they are the more nearly they can afford to be installed as indirect reflectors, and the less dense they are the more nearly they should be installed as direct reflectors.

In providing general illumination the most difficult problem is encountered in the lighting of rooms of low and medium height. In rooms whose ceilings are very high in proportion to the other dimensions, comparatively good results should be gotten with almost any reflector of modern design. The loss of efficiency sustained by the eye in an unfavorable lighting situation seems to be muscular, not retinal.

The best protection for the individual is afforded by an opaque eye shade with a light lining. Opaque eye shades with a dark lining create a very unnatural brightness relation—i. e., they make the upper half of the field of vision dark, in sharp contrast with the brightly lighted lower half. The direct effect of this is a strong brightness induction (physiologic) over the lower half of the field of vision which causes glare in surfaces which have no glare and increases the glare in surfaces in which glare is already present. Moreover, the rim of the shade, the sharply marked boundary between the light and dark halves of the field of vision and much nearer to the eye than the objects viewed, serves as a constant and consciously annoying distraction to fixation and accommodation. The complex and somewhat contradictory impulses given to the muscles of the eye doubtless cause excessive and unnatural loss of energy and efficiency in case of the prolonged adjustment needed for a period of work.

Skylight illumination. The following description of this useful

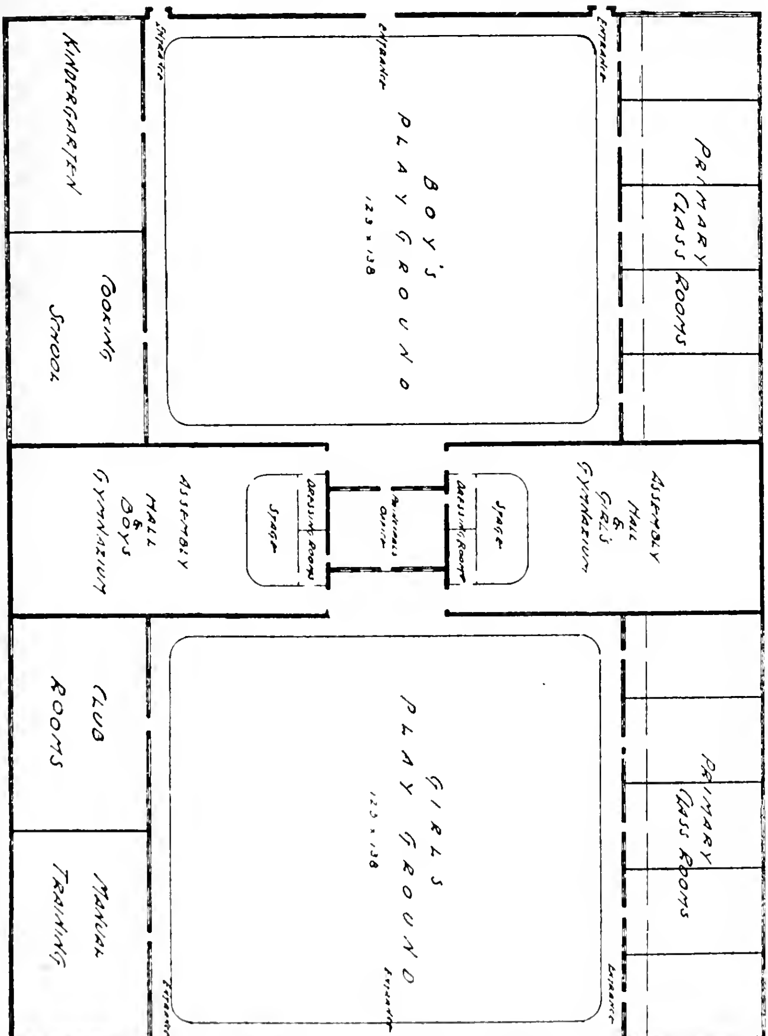
Skylight Illumination for Schools. (Baker.)
Perspective. One Story Arcade School Building. Lot 300 x 300 feet. Building 300 x 220 feet, 22 rooms and Assembly Hall.



Skylight Illumination for Schools. (Baker.)

form of school lighting is contributed by the inventor, Dr. L. K. Baker, of Cleveland, Ohio:

The figures illustrate a system of north side saw-tooth skylights for



First Floor Plan for a 30-Room Two Story Building.

each class-room in a two-story school building with interior playgrounds lighted by ordinary skylights.

The section shows the arrangement of spaces in the basement and between the walls of first floor rooms, and interior courts for warm air ducts and plumbing.

Omitting the second floor rooms obtains a one-story building of the same type.

The advantages of this type of lighting, already realized in industrial buildings, should also be utilized for school class-rooms. By arranging these in the building plans so that the left ends of the desks are toward the skylight an even and abundant north light is invariably thrown upon each desk top. This it is impossible to obtain with the best forms of side lighting, for many teachers can never be induced to adjust their window shades so as to light all of the desks. Of course, unnecessary, unilateral, window lighting can be used with the skylights, if desired.

It will be borne in mind that in these proposed school buildings the rooms are planned so that all pupils face eastward so that, as suggested, the light may come in from the left side.

The importance of this suggestion will at once be apparent to ophthalmologists and architects who have made an extensive study of school-room lighting. All will agree that as the light on the desk top decreases the pupil bends nearer to his desk work, throwing more and more strain upon the nervous system and ocular muscles.

A daily record of weather conditions as affecting the use of playgrounds during six months of the year in northern cities, indicates that for the inclement half of the year properly lighted indoor playgrounds should be used as supplementary to the outdoor play-grounds.

Godinez (*Oph. Year-Book,* p. 393, 1916) says it is important to remember that there is *no preconceived method of lighting applicable to school rooms,* or any interior in general. Each condition is in itself a special problem requiring special, painstaking consideration, but does it ever receive it? An electric bulb emits less light from either end than from the sides, with the inverted gas mantle the reverse is true. The semi-indirect method of artificial illumination is considered by Godinez as the best. He recommends, in case an architect is not capable of designing suitable lighting, that some one who is should be retained for the purpose and held responsible for results. The extraordinary phase of the situation is that schools are built year after year, yet the same absurd mistakes in lighting recur continually.

School inspection. The laws of various lands relating to this subject will be found under **Legal relations of ophthalmology**, in last third of the section. See, also, **Conservation of vision.**

Frank Allport (*Interstate Med. Journ.,* XX, Nos. 7 and 8, 1913) believes that the hygienic and medical supervision of schools may be participated in both by the Boards of Health and Boards of Education; the former to be particularly and authoritatively interested in

those phases of health problems, which affect the public health, such as contagious diseases, unsafe school buildings, etc., while the latter may take in hand the physical defects of children, such as eye, ear, nose and throat diseases, nervous and mental conditions, etc. It is probably the opinion that in a broad, general way the medical inspection of schools, excepting those physical conditions which menace the public health, is best carried on by the educational rather than by the health authorities. It seems better that such matters be controlled by the various local boards of education. It gives a greater freedom of action than could be obtained in any other way. Of course, the educational authorities should work in thorough harmony with the health authorities, and all health laws should be absolutely observed. Reciprocity between the two bodies should be extended, and it is especially important that neighborhoods where contagious diseases have broken out, should be instantly reported by the Board of Health to the school authorities so that suspected scholars may be suspended from school, and thus materially mitigate the frequency and potency of school epidemics.

Allport has collected and published the laws regulating the inspection and conduct of schools from the ophthalmic standpoint in the United States.

School myopia. That form induced by the eyestrain incident to the near work needed to acquire an education. See **Myopia**, p. 8265, Vol. XI of this *Encyclopedia*, as well as under **Refraction** and **School hygiene.**

Schools for the blind. See **Institutions for the blind.**

Schools of ophthalmology. See **Teaching methods.**

Schott's glass. This is one of the many materials out of which (neutral) tinted lenses are manufactured, as a protection against both natural and artificial glaring.

Schreger, Christian Heinrich Theodore Theophilus. The younger brother of Bernhard Nathaniel Schreger, and himself a general surgeon of some ophthalmologic importance. Born Jan. 20, 1768, at Zeitz, he studied at first jurisprudence, then political economy. For a time he was tutor in a private family. At length, in 1794, he began to study medicine at Wittenberg. Soon, however, he migrated to Altdorf and then to Erlangen (where his brother was teaching) at the latter institution receiving his degree in 1800. For a time he practised at Erlangen, but, in 1810 removed to Wittenberg in order to accept the chair of chemistry and materia medica. After a considerable period of service in the army in a medical capacity, he was called to the chair of medicine in Halle. Here he died Dec. 29, 1833.

In addition to works of a general character, he wrote "*Versuch einer Vergleichenden Anatomie des Auges und der Thränenorgane der Menschen*" (Leipsic, 1810).—(T. H. S.)

Schriftblindheit. (G.) Word blindness.

Schrumpfung des Augapfels. (G.) Phthisis bulbi.

Schubert, Paul. A celebrated German ophthalmologist and otologist, known especially for his work in school hygiene. Born at Neisse in Silesia, Jan. 17, 1849, he studied at Breslau, Berlin, Würzburg and Vienna, receiving his medical degree in 1876. Three years later he settled as ophthalmologist and otologist in Nürnberg. He died in 1905, aged 56.

His more important ophthalmologic writings are: 1. *Ueber Syphilit. Augenkrankheiten.* (Berlin, 1881.) 2. Schiefsschriftfrage. (*Aertzl. Intelilgenzblatt,* 1881; 1882; *Berliner Klin. Wochens.,* 1884.) 3. *Schulbankfrage.* (*Aertzl. Intelligenzo.,* 1881.) 4. Schulbücherdruck. (*Mittheil. des vereines f. Oeffentl. Gesundheitspflege,* Nuremberg, 1882.) 5. Retinitis Syphilitica. (*Centralblatt f. pkt. Augenh.,* 1881.) 6. Amaurose bei Bleivergiftung. (*Aerztl. Intelligenzblatt,* 1880.)—(T. H. S.)

Schubert's pupillary sand. Punctiform remnants of the fetal pupillary membrane. Stähli (*Klin. Monatsbl. f. Augenheilk.,* p. 432, April, 1913) found them in about 27 per cent. of eyes affected by various diseases, and regarded them as the commonest form of these vestigial remains. See, also, **Pupillary membrane.**

Schulek, Wilhelm. A well-known Hungarian oculist, editor of the oculistic supplement, "*Szemészet*" of the "*Orvosi Hetilap.*" Born at Budapest, Hungary, in 1843, he studied medicine at Vienna, where he received his medical degree. After a year or more in the study of ophthalmology in Berlin, Paris and London, he served from 1867 till '72 as assistant in Arlt's Eye Clinic at Vienna, and in 1872 was made full professor of ophthalmology at Klausenburg. Two years later he was called to the corresponding chair in Budapest, where he taught and practised till his death. He also founded here an ophthalmic hospital. He died Mar. 14, 1905, aged 62.—(T. H. S.)

Schultze, Max Johann Sigismund. The son of a famous anatomist and physiologist, Karl August Sigismund Schultze, and himself a distinguished anatomist of much ophthalmologic importance. Born Mar. 25, 1825, at Freiburg, Germany, he studied at Greifswald and Berlin, returning, however, to Greifswald in 1849 in order to receive his medical degree. From 1850-'54 he was prosecutor and privatdocent in Greifswald, from 1854-'59 in Halle, and from 1859 until his death he was director of the Anatomical Institute in Bonn. He died at Bonn, Jan. 16, 1874.

His services in connection with the further development of the cell theory and to comparative anatomy and physiology were truly very great. To him, in fact (together with Brücke and Beale), is owing the absolute rejection of the cell-membrane as an essential portion of the cell. In the words of Waldeyer, "He became thereby the creator of the modern conception of the cell." Hardly less important were his services in connection with microscopic technique.

For the ophthalmologist the following articles of Schultze possess an especial interest: 1. Note sur une Matière Colorante Existant chez Plusieurs Animaux et Identique avec la Chlorophylle Végétale. (*Compt. Rend.*, 1852.) 2. Zur Kenntniss des Gelben Fleckes und der Fovea Centralis des Memschen und Affenauges. (*Ib.*, 1861.) 3. Zur Kenntniss der Leuchtorgane von Lampyris Splendidula. (*Archiv f. Mikr. Anat.*, 1, 1865.) 4. Zur Anat. u. Physiol. der Retina. (*Ib.*, II, 1866.) 5. Untersuchungen über die Zusammengesetzten Augen der Krebse und Insecten. (Bonn, 1868.) 6. Ueber die Nervenendigungen in der Netzhaut des Auges bei Menschen und bei Thieren. (*Archiv f. M. Anat.*, V.) 7. Neue Beiträge zur Anat. u. Physiol. der Retina. (*Ib.*, VII.) 8. Die Retina. (Stricker's *Handbuch der Lehre von den Geweben.*) 9. Ueber die Retina der Neunaugen. (*Sitzungsber. der Niederrhein. Gesellsch.*, 1871.) 10. Ueber den Bau der Netzhaut von Nyctipithecus Felinus. (*Ib.*, 1872.) 11. Ueber die Netzhaut des Störs. (*Ib.*, 1872.)—(T. H. S.)

Schurig, Martin. A German physician, who paid considerable attention to ophthalmology. He received his medical degree at Erfurt in 1688, and practised at Dresden until his death in 1733.

Schurig edited and elaborated Verbrugge's German translation of Guillemeau's "*Traité des Maladies de L'Oeil*" under the title, "*Der Aufrichtige Augen- und Zahnarzt, oder 113 Augenbeschwerungen mit ihren Ursachen, Signis, und Curen,*" Dresden, 1810).—(T. H. S.)

Schussverletzungen. (G.) Injuries from projectiles.

Schuster, Michael Philip. A prominent ophthalmologist and otolaryngologist of El Paso, Texas, and founder of the Providence Hospital in that city. Born in Gyor, Hungary, in 1869, he received his medical degree in 1889 at the University of Vienna, Austria. For the next three years he was chief assistant to the celebrated Ernst Fuchs.

Coming to America, Dr. Schuster settled in Kansas City, where, for a time, he was chief surgeon to the American Smelting and Refining Co. He also taught for a number of years in the Kansas City College of Medicine.

Removing to El Paso, Texas, the Doctor remained chief surgeon to the American Smelting and Refining Co., a position which he held,

all told, for eighteen years. In 1905 he was President of the El Paso County Medical Society. He was also a Fellow of the American College of Surgeons and a thirty-second degree mason.

Dr. Schuster died at his home on Nov. 15, 1918, after a year or more of illness. He was survived by two daughters and by two sons—Dr. Stephen Schuster, commander of Base Hospital 129, Camp Shelby, Hattiesburg, Miss., and Dr. Frank P. Schuster, Medical Reserve Corps, Cook County Hospital, Chicago.—(T. H. S.)

Schutzbrillen. (G.) Protective glasses.

Schwachsichtigkeit. (G.) Asthenopia.

Schwarzer Staar. (G.) Black cataract.

Schwefel. (G.) Sulphur.

Schweigger, Karl Ernst Theodor. A famous German ophthalmologist. Born at Halle a. S., Oct. 29, 1830, the son of Johann Salomon Christoph Schweigger, professor of physiology at the Hallean University, the subject of this sketch studied medicine both at Erlangen and at Halle. At the latter institution he received the degree of M. D. in 1852. For a time he served as assistant in internal medicine to Krukenberg. Turning his attention, however, to ophthalmology, he proceeded in 1856 to Würzburg, where, for some months, he studied with Müller the microscopical anatomy of the eye. In 1857-'64 he was assistant to A. von Graefe in Berlin. In 1860 he qualified as privatdocent for ophthalmology at the Berlin University. In 1867-'68 he made an extensive scientific journey to Holland, England and America. Returning to Germany, he was made professor extraordinary of ophthalmology at Göttingen, as well as director of the newly founded Ophthalmic Hospital in that place. In 1871, however, he was called to Berlin in succession to von Graefe, who had just died. He did not, however, attain to the title of professor extraordinarius till 1873. In 1885 he was made privy medical advisor. Five years later, he retired from active service, and, in 1905, he died, after a long and painful illness.

Schweigger's ophthalmologic writings are numerous and valuable. For many years he was associated with Herman Knapp as German editor of the newly founded *"Archives of Ophthalmology"* (title of the German edition, *"Archiv für Augenheilkunde"*), and, in this capacity, performed much useful literary work. He also wrote a *"Handbuch der Augenheilkunde"* (Berlin, 1871) which soon became a classic, and, in fourteen years, attained its fifth edition. A second book was the justly celebrated *"Klinische Untersuchungen über das Schielen"* (Berlin, 1881; Eng. trans. by Gustavus Hartridge). His more important journal articles are: 1. Ueber Amblyopien bei Nieren-

leiden. (Graefe's *Archiv* VI.) 2. Ueber Entstehung des Capselstaares. (*Ib.*, VIII.) 3. Beschreibung eines Demonstrations-Augenspiegels. (*Ib.*) 4. Sehproben. (Berlin, 1877.) 5. Beobachtungen über Netzhautablösungen. (*Archiv f. A.*, XII.) 6. Resection des Opticus. (*Ib.*, XVI.) 7. Vordere Synechie ohne Perforation der Hornhaut. (*Ib.*, XVII.) 8. Die Erfolge der Schieloperation. (*Ib.*, XXIX.) 9. Glaucoma Malignum. (*Ib.*, XXX.) 10. Extraction mit Lappenschnitt nach unten ohne Iridectomie. (*Ib.*, XXXVI.)—(T. H. S.)

Schweinfinne. (G.) Cysticercus cellulosæ.

Schwerflint. A glass of German manufacture for protecting the eyes against excessive light. See **Ultra-violet rays.**

Schwund der Iris. (G.) Atrophy of the iris.

Sciagraphy. SKIAGRAPHY. (a) The art of determining the time of day or night by the shadows caused by some heavenly body. (b) The art of correct shading.

Sciametry. The scientific doctrine of eclipses.

Sciascopy. Same as skiascopy.

Sciatheric telescope. A dial with a telescopic attachment for giving the time by means of shadows.

Scie. (F.) Saw.

Scie à molette. (F.) Trephine.

Scieropia. (Obs.) A defect of vision, in which all objects look unnaturally dark, or in shadow.

Scintillascope. Same as spinthariscope.

Scintillating scotoma. See **Migraine**, p. 7695, Vol. X of this *Encyclopedia.*

Scintillation. Emission of sparks. "Twinkling" of the stars is familiar to all who have directed their attention to the firmament above us. Under ordinary atmospheric conditions this flickering is possessed only by the so-called fixed stars. A planet shines steadily, and by this mark can readily be picked out. When near the horizon, however, planets have been observed to scintillate slightly; while stars at low altitudes invariably twinkle more vigorously than stars overhead. This at once points to the atmosphere as an important factor, since the phenomenon is more pronounced when the light has to traverse a greater depth of air. Scintillation may be said to depend on three factors: (1) the vast distance even of the nearest stars reducing the largest of them to mere points of light; (2) the ever-changing variableness in condition of the atmosphere through which the light must come to us; (3) the smallness of aperture of our eye, which receives an almost ideal single ray of light.—(*Standard Encyclopedia.*)

Scintillometer. An instrument for determining the amount of stellar scintillations.

Scioptic ball. A perforated wooden ball containing a lens, used to project a picture on to a screen or table.

Scioptic. SCIOPTRIC. Of, or pertaining to, the camera obscura.

Sciopticon. A "magic" or projection lantern.

Scirrhencanthis. (L.) (Obs.) A scirrhous disease of the lachrymal gland.

Scirrhoblepharoncus. (L.) See **Scleriasis palpebrarum.**

Scirrhophthalmia. An old term for cancer of the eyeball.

Scirrhophthalmia palpebrarum. (L.) See **Scleriasis palpebrarum.**

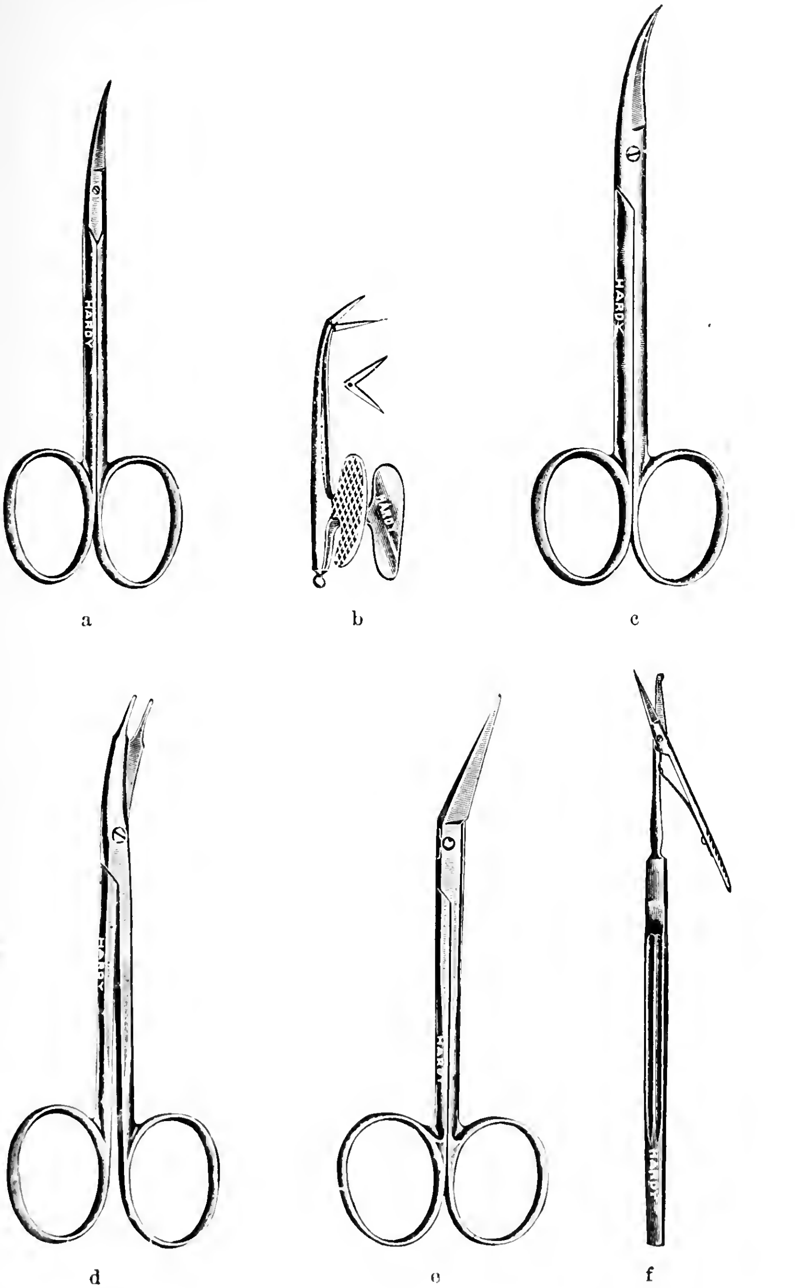
Scirrhus. Carcinoma or "hard" cancer.

Scissors, Ophthalmic. This subject should be read in conjunction with **Instruments, Ophthalmic,** p. 6526, Vol. IX of this *Encyclopedia;* also see the various operation captions, such as **Cataract; Iridectomy; Muscles, Ocular; Enucleation,** etc. The sub-captions here given will be considered mostly in alphabetical order.

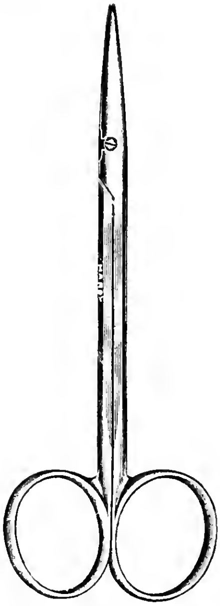
Landolt (Wood's *System of Ophthal. Operations,* Vol. I, p. 496) believes that the handling of scissors should be governed by the same principles as that of the other instruments. They should be steadied between the extremities of the fingers only, and the active part of the instrument should be as near as possible to the finger-tips.

To attain his purpose the scissors should be held by the extremities of the first four fingers. The end of the last phalanges of the thumb and ring finger are delicately inserted in the rings of the scissors, so that the simple movement of those two will open or close the blades. The index finger, which, of course, should be curved, is applied to the crossing. The extremity of the middle finger is applied, on the opposite side, to the ring and corresponding handle. Thus the scissors are steadied by the thumb and ring finger on the sides, by the index finger above, and by the middle finger underneath. They can escape in no direction, and can even be turned over without any difficulty. Moreover, they can be worked with the greatest lightness.

This method of holding the scissors has another great advantage. Owing to the fourfold contact of the instrument with the most sensitive parts of the fingers, the scissors are no longer simply a cutting forceps, they become a most sensitive probe, and can give most valuable information as to the nature of the tissues with which they come in contact, and as to the precise situation of the points of the blades. Moreover, the tip of the index finger being as near as possible to the active part of the instrument, it can be handled with the greatest degree of precision.



Scissors. a. Noyes', b. Angular (sharp iris), c. Blunt (strabismus), d. Stevens' (strabismus), e. Liebold's (iris), f. Small strabismus.



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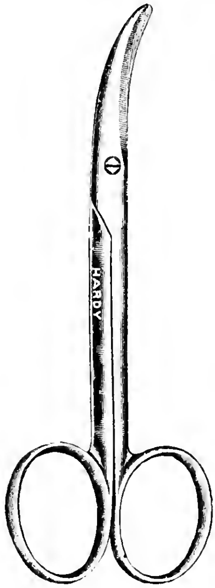

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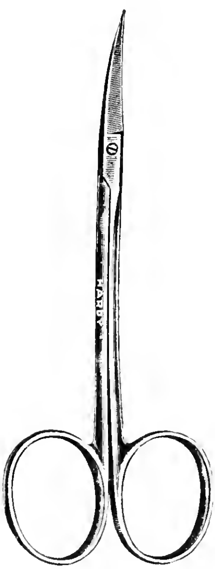

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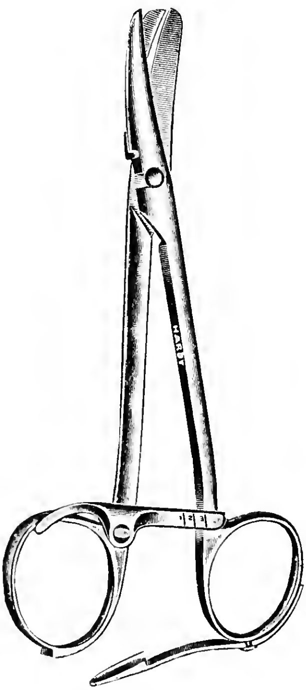

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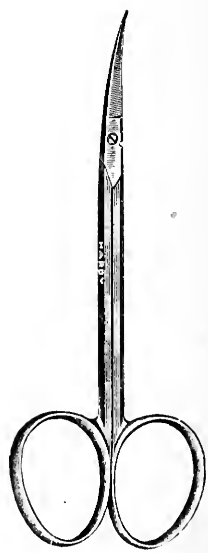

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Scissors (continued). g. Straight sharp iris, h. Enucleation (slight curve), i. Blunt strabismus (straight), j. Curved sharp point iris, k. Enucleation (with hemostatic clamp), l. Sharp iris (curved on the flat).

To ensure proper handling, the scissors should be proportionate to the hand of the operator. The hand being half-opened and the thumb and ring finger being inserted in the rings, the tip of the curved index finger should rest exactly on the lock.

The scissors usually supplied to the profession do not always fullfil this condition; very often the handles are too long and the operator, if his hand is small or medium-sized, is obliged to extend outwards his index finger, and by so doing mars the lightness of his movements.

Generally the scissors are unnecessarily pointed and the handle too delicate. The blades should be thin in most of the scissors used in ophthalmological practice, but the handle should be strong and solid.

G. A. Critchett's scissors for dividing *anterior synechia* (*Trans. Oph. Sos., U. K.*, 1889, p. 196) have a convex curvature of the blades which enables them to be brought into close apposition to the posterior surface of the cornea.

P. H. Mules' *enucleation scissors* (*Trans. Oph. Soc. U. K.*, 1880, p. 219) are ordinary strong scissors curved on the flat, but with the addition of two sharp points projecting backward at an angle of 35°, which rotate and lift out the globe at the same time.

Wm. Ellery Briggs' *ablation scissors* (*Archives of Ophthal.*, Vol. XVI, No. 1) consist of two curved scissors, placed parallel so as to enable one to cut a section of the optic and ciliary nerves without cutting any of the ocular muscles.

In 1894 Dr. Briggs modified his ablation scissors by adding a pair of claws between the two scissors to insure the removal of the cut section of the nerves. (See *Trans. Sec. Oph., A. M. A.*, 1894, p. 177.)

C. Griffin Lewis' new instrument for *partial tenotomies* (*Annals of Oph.*, April, 1907, p. 281) are scissors bent in a half curve so that a crescent-shaped piece of the muscle may be clipped off at one stroke.

C. D. Westcott's *tenotomy scissors* (*Ophthalmic Record*, Sept., 1897, p. 480) is a modification of the Stevens instrument and is made with spring handle.

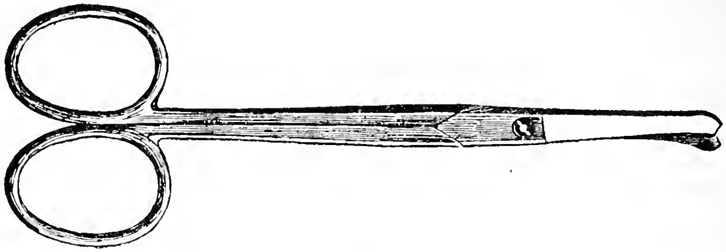
Samuel Theobald's *iris scissors* (*Trans. Amer. Oph. Soc.*, 1901, p. 398) are made with the curve of the blades reversed, so that the concavity of the blades should be applied to the convexity of the corneal border. They are made with spring handle.

Agababoff's *enucleation scissors* have one of the blades blunt pointed. See the figure.

Arlt's *canaliculus scissors* present one blade longer than its fellow for easier introduction into the canal. See the illustrations, which show the instrument both open and closed.

Frisch's *curved-handle scissors* are the same as the de Wecker model

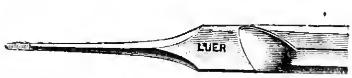
(see cut) except that the shank is bent to bring the rings at approximately right angles with the shank. The purpose of this is to bring



Enucleation Scissors of Agababoff.

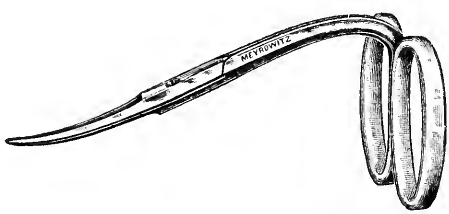
the hand into an easier position when operating, bringing the operator's hand nearer the eye, permitting him to rest a finger or fingers on the

Arlt's Canaliculus Scissors, Open.



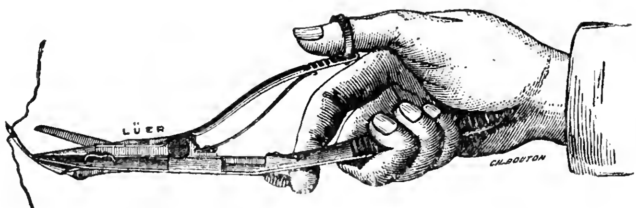
Arlt's Canaliculus Scissors, Closed.

patient's face. It was with this purpose in view that the de Wecker scissor was devised.



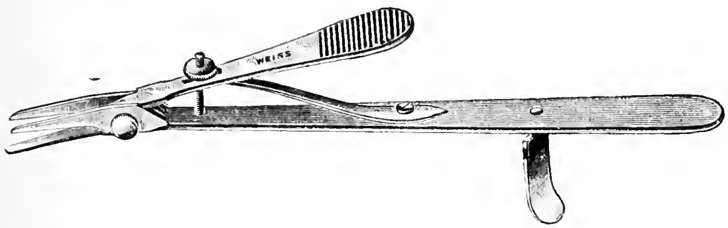
Curved-Handle Scissors. (Frisch.)

The purpose of Gazepy's combination "set" for performing canthoplasty (q. v.) is sufficiently indicated by the accompanying cut.



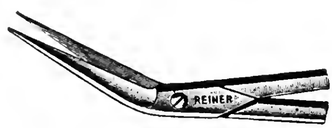
Gazepy's Combined Canthoplasty Scissors.

Harman's *twin-scissors for sclerotomy.* The inventor (*British Med. Journ.,* Jan. 21st, 1911) says "In operating with this instrument I have found it convenient to first turn forward a flap of conjunctiva from the chosen site of the sclerotomy; then the keratome is inserted



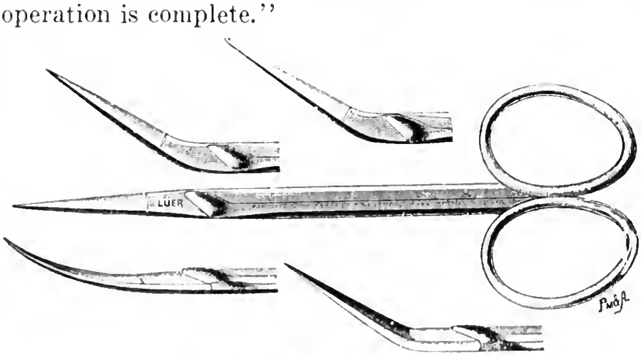
Harman's Twin-Scissors for Sclerotomy.

into the sclerotic 4 mm. from the clear corneal margin and passed through and under the sclerotic until its point appears within the corneo-iridic angle; it is pushed on until a clear 3 mm. of the blade is within the anterior chamber; the keratome is then withdrawn. Now



Scissors for Iridectomy. (French model.)

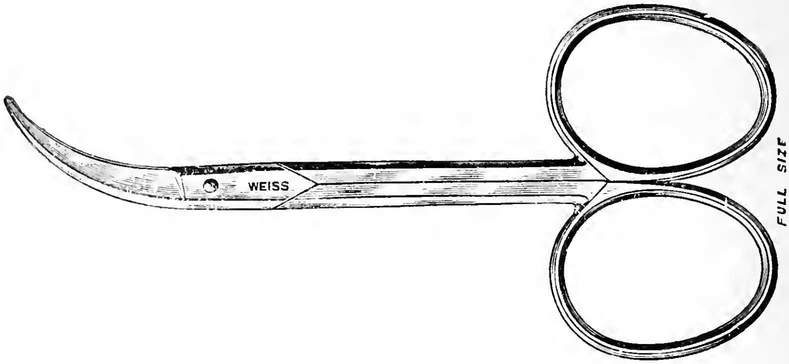
the male blade of the twin-scissors is pushed along the track of the wound until the projecting 2 mm. of the blade shows within the anterior chamber; the scissors are then closed, the cuts made, the male blade gently withdrawn and with the replacement of the conjunctival flap the operation is complete."



Richter's Muscle Scissors.

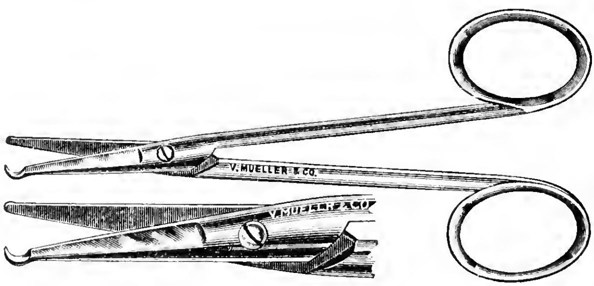
Heuss' *canalicalus scissors* has one long blade furnished with a probe point, the other short and sharp pointed. The longer branch is passed through the punctum into the canalicalus and the canal is cut open as far towards the sack as seems desirable.

A number of French models of *iridectomy scissors* are depicted here- *Sickle-shaped* and *sharp scissors* have their occasional uses, especially in muscles operations. See the cut.



Sickle-Shaped Scissors.

Scissors for the removal of stitches especially after operations on the ocular muscles are very useful. A cut of Spencer's stitch scissors is shown in the text.



Spencer's Stitch Scissors.

Scissors-handled punches. These instruments are for special purposes which are indicated under the headings devoted to their particular use.

Scissors-Handled Punches. a. Arlt's (for iris growth), b. Stevenson's (capsule).

Scissors movement. While the shadow movements in *skiascopy* (q. v.) are easily understood, there is a phenomenon known as "scissors movement" which is confusing to the beginner. It consists in two bands of light (usually horizontally placed), separated by a dark band. When the mirror is moved slowly, the two bands of light approach

and close over the dark area: hence the name "scissors-like movement." The phenomenon indicates irregular astigmatism.

Sheard (*Ophthalm. Record*, August, 1916) agrees that this movement sometimes seen during the retinoscopy test may be due to obliquity or imperfect centering of one or other of the dioptric surfaces, such as occurs in ectasia corneæ; or to slight tilting of the lens. He concludes that the retinoscopic findings should be obtained as nearly as possible in the direct line of sight. When a scissors movement arises, determine the position of the single band just as the two bands close together and again the position of the division line just as the two bands reappear; correct by the addition of cylinders the astigmic band which contains within itself the center of the pupil or which gives evidence that it discloses the chiefly usable portion of the eye (visual zone). In cases of doubt, correct the nasal or the lower portion of the double reflex respectively and confirm by rigid subjective testing. A slight over-correction of the meridian first corrected may either do away with the scissors movement or aid in the determination of which portion thereof is to be corrected. A narrow stenopaic slit is a valuable corroborative test. See, also, **Skiascopy** and **Skiametry.**

Sclarea. The flowers of this plant—*Salvia sclarea*—are made into an infusion and used as a domestic remedy in various form of "sore eyes," just as chamomile (q. v.) "tea" is employed abroad. The plant contains a small amount of tannin and volatile oil to which, presumably, its virtues are due.

Sclera. SCLEROTIC. SCLEROTICA. The external coat or tunic of the eye. See, for a description of the gross anatomy, histology and development of this ocular coat especially, p. 372, Vol. I; p. 5949, Vol. VIII, and p. 3911, Vol. V of this *Encyclopedia*. The same subjects are treated for the lower animals in various portions of **Comparative ophthalmology.**

Attention is also drawn to the work of G. Attias (trans. by C. Lol, *Annals of Ophthalm.*, Jan., 1913; abstracted in *Ophthalmology*, p. 602, July, 1913), on the intrascleral nerve loops. Axenfeld had previously reported a peculiar course of the ciliary nerves in the anterior portion of the eye in a case where the nerves, after they had traversed the suprachoroidea and had reached the flat portion of the corpus ciliare, passed perpendicularly through the sclera and frequently touched the conjunctiva, after which they turned, passed through the sclera in the opposite direction and then spread out in the corpus ciliare. These nerves, therefore, formed a loop in the sclera, and were called intrascleral nerve loops. Attias found during the examination of scleral sections of the anterior portion of the bulb three cases of intrascleral

nerve loops. These loops are found usually in the superior portion of the eye. The distance of the loop from the limbus varies from 3.5 mm. to 1.7 mm. The loop itself can be divided into a proximal and a distal portion. The path of the loops through the sclera are usually perpendicular, but may be oblique and even run some distance within the scleral fibers. Nerve branches may shoot off from the loop and run to the cornea. It is unusual to find more than one loop in one bulbus. The author examined one eye in which two loops were found, one large, the other small.

Sclera, Abscess of the. Suppuration as a primary condition is extremely rare. Metastatic abscess of the episclera is, perhaps, commoner but it, too, is quite uncommon. The latter has followed pyemia, carbuncle, furunculosis and epidemic meningitis.

Meissner (*Oph. Year-Book,* p. 141, 1913) reported a case of scleral abscess at the limbus, which gave negative Wassermann and tuberculin reactions. It started as a swelling, finally forming an abscess which had to be opened. The staphylococcus aureus was found in smear and culture. He considered it to be metastatic from a prostatitis and cystitis, as an excitant in the urine was easily demonstrated, although culture from the blood was negative. One day after the scleritis appeared, a large abscess showed on the buttocks. Murakami saw a case of necrotic, hemorrhagic ulcer with concentric enlargement, from the sclera to the cornea, which formed part of a metastatic process starting in a streptococcic infection of a tooth. The patient died of sepsis.

Sclera, Anomalies of the. Congenital malformations of the sclera. These include melanosis, tumors, and certain staphylomas. Congenital pigmentation of the sclera (melanosis scleræ) presents either small spots or diffuse areas of discoloration. Generally there are similar conditions in the iris and choroid. It is around the openings for the passage of the anterior ciliary veins and about the optic-nerve entrance that branching pigment-cells are found. See p. 7634, Vol. X of this *Encyclopedia.*

Peters (*Oph. Year-Book,* p. 309, 1913) observes that congenital malformations of the sclera generally affect the whole extent of this tunic, which is so thinned that the choroidal pigment shows through plainly.

The anomaly is usually hereditary. In the author's case the cornea was ectasic and under the microscope the sclera had a lamellated structure just like the cornea, indeed the two structures were strikingly similar in all their characteristics. Congenital staphyloma of the cornea has been exhaustively studied by Wirths and by Collins and Hudson. Wirths' microscopic examination revealed other malformations, such

as retained nerve fibers, deficient development of Schlemm's canal and defects in Descemet's membrane. He leans to the view that embryonic variation, rather than intrauterine inflammation, was responsible for the anomaly. In Collins' and Hudson's case the eyeball was removed from an 11-month-old child. In addition to the corneal opacity the iris was in contact with the posterior surface of the cornea and there was an intercalary staphyloma above the cornea. Microscopically there was entire absence of intraocular inflammatory exudate and the uveal tract was free from cellular infiltration. The authors argue that the anomaly was of developmental origin, the malformation occurring before the differentiation of Descemet's membrane and the formation of the anterior chamber.

Sclera, Argyrosis of the. SILVER STAINING OF THE SCLERA. When this form of staining occurs it is usually an accompaniment of argyrosis conjunctivæ (q. v.), but Hirschberg has described a scleral argyrosis in an old silver polisher whose scleræ were dark grayish-blue—probably from the lodgment in it of fine silver particles.

Sclera, Blue. See **Sclerotics, Blue**; as well as p. 1237, Vol. II, and p. 5146, Vol. VII, of this *Encyclopedia.*

Sclera, Brawny infiltration of the. See **Scleritis, Brawny.**

Sclera, Calcification of the. This condition is occasionally found in degenerated eyes.

Sclera, Cyst of the. Cysts of the sclera are of rare occurrence. Serous cysts have been recorded by Rogman and Hasner. The origin of such tumors is in doubt. Some authorities hold that they are dilations of the canal of Schlemm. Others state that they are due to a congenital fistula from the anterior chamber into the sclerotic, which permits the aqueous humor to pass between the lamellæ of the sclera. Some authors attribute them to encysted choroidal exudates producing small staphylomata of the sclera. The diagnosis may present difficulties. In Rogman's case the tumor collapsed on puncture without change in the anterior chamber.

One of the few recorded instances of cystic tumors of the sclera occurred in a young girl of 12 years, reported by Perrod (*Oph. Year-Book*, p. 164, 1914). She had lost the sight of the right eye four years previously from a penetrating injury. On account of pain in this eye which was phthisic, and of slight disturbance of the sound eye, the blind eye was enucleated. Upward and outward from the limbus of this eye was a violaceous patch. Microscopic section showed in the region corresponding to the scleral patch a cyst larger than the anterior chamber, and situated entirely in scleral tissue. The anterior wall was composed of scleral tissue, the posterior of cicatri-

cial tissue secondary to the perforating wound. The large cyst was divided into two parts by fibrous tissue, and there was another smaller cyst also in the sclera. All the cavities were lined throughout by epithelium in several layers; the deeper layers formed of cuboidal cells, and the more superficial (those next to the fluid content of the cyst) being flattened. Some of the sections clearly showed the origin of this epithelium to be from the conjunctival epithelium next to the limbus.

Sclera, Ectasia of the. STAPHYLOMA OF THE SCLEROTIC. This subject has already been discussed and illustrated on p. 4136, Vol. VI of this *Encyclopedia.* In addition it may here be said that Mattice reports a case of scleral staphyloma, which contrary to the description of scleral ruptures by Fuchs, and to the generally accepted views of Bienbacher and Czermak on pathogenesis of scleral staphyloma, occurred neither at the entrance of the ciliary vessels nor of the nerves, but at the equator. Neither was there any evidence of inflammatory process to be observed in his case. A case of scleral ectasia was reported by Sedgwick, where the uveal color showed through the sclera to a marked degree and in which the history, though vague, pointed to a probable ophthalmia neonatorum.

Sclera, Enchondroma of the. Cartilaginous tumors of this eye coat are exceedingly rare.

Sclera, Foreign bodies in the. These are not often seen, since such substances are generally propelled with force sufficient to cause them to enter the vitreous chamber. However, pieces of iron, steel, glass, stone, percussion-caps, grains of gunpowder, etc., sometimes lodge in the sclera. If not visible, their location can often be determined by x-ray examination. In case the suspected foreign body is of iron or steel, the sideroscope may be useful in diagnosis, or the Haab magnet can be used. The latter localizes the foreign body by the pain which follows its application. See, also, **Injuries of the eye.**

Sclera, Granuloma of the. See **Scleritis, Brawny.**

Sclera, Gumma of the. This syphilitic neoplasm is so rare that only about thirty cases have been reported, and they occurred from ten months to eight years after the chancre. E. M. Blake and J. E. Lane (*Jour. Amer. Med. Ass'n.,* Dec. 30, 1916) (who describe a case) point out that the structure of the sclera probably explains the infrequence of the development of gummas in it. The dense fibrous tissue and the few elastic fibers of which it is composed form a strong, hard and inelastic tissue, which is not a favorable ground for the development of the rounded, limited, elevated growth, hard at first and tending to soften and break down in the center, which is typical of the gumma.

Deep scleritis frequently shows some nodules which are too small and too irregular to be classed as gummas. These nodules are frequently multiple, and the two eyes are frequently affected at the same time. This condition is usually refractory to treatment and is frequently complicated by opacities in the cornea, iris and vitreous, and by other secondary changes in the other coats of the eye. Fuchs states that recurrent scleritis does not ordinarily have a syphilitic origin, but that isolated nodules are sometimes found in the sclera as a result of syphilis. It is very likely that these nodules in rare cases develop into gummas.

The case described was a man 38 years of age with no history of syphilis, but who had had moderate doses of mercury and iodid. On the temporal side of the left sclera there was an oval tumor measuring about 4 mm. by 6 mm. and raised about 3 mm. above the level of the surrounding sclera. It was yellowish-red, slightly tender, distinctly hard, and covered by dilated conjunctival vessels. The sclera about the tumor was of a slaty blue. Several tuberculin tests made were negative. The Wassermann reaction was strongly positive. Four injections of salvarsan were given at intervals of one week. These were followed weekly by injections of mercurial oil. The tumor began to decrease in size shortly after the first dose of neosalvarsan and after eight weeks nothing was left but a slaty-blue spot. See, also, p. 5658, Vol. VII of this *Encyclopedia.*

Sclera, Inflammation of the. See **Scleritis.**

Sclera, Injuries of the. These are simple, perforating and compound according to the character of the agent producing the trauma. Foreign bodies may also lodge in its tissues.

The treatment is mostly operative, although the removal of foreign bodies and the disinfection of all lesions are most important.

Ectasia (acquired) of the sclera, staphyloma of the sclera, serious injuries of the sclera, sclerosing scleritis, pigmentation of the sclera, congenital anomalies and tumors are unaffected by any medical treatment. See, also, **Injuries of the eye**; also, **Scleral suture.**

Scleral. Of, or pertaining to, the sclerotic coat of the eye.

Sclerale (anello). (It.) Scleral ring.

Sclera, Leprosy of the. The (episcleral) nodules of this disease are occasionally seen; the infection invades the tissues along the perivascular and interlamellar lymph-spaces. See p. 7431, Vol. X of this *Encyclopedia.*

Scleralkranz. (G.) Circulus arteriosus nervi optici.

Scleral ring. Scleral crescent. See p. 5316, Vol. VII of this *Encyclopedia.*

Scleral suture. See p. 6262, Vol. IX of this *Encyclopedia.* See, also, **Suture, Scleral.**

Sclera, Malformations of the. See **Sclera, Anomalies of the.**

Sclera, Massive granuloma of the. See **Scleritis, Brawny.**

Sclera, Melanosis of the. See p. 7634, Vol. X of this *Encyclopedia.*

Sclera, Mycosis of the. Fungous disease of the sclera is exceedingly rare. Köllner has reported such a case following injury.

Sclera, Ossification of the. This is a rare condition found only in markedly degenerated eyeballs.

Sclera, Osteoma of the. A very rare neoplasm. An example has been described by Watson.

Sclera, Paracentesis of the. See **Hancock's operation,** p. 5543, Vol. VII of this *Encyclopedia.*

Sclera, Pigmentation of the. See **Pigmentation of the Sclera,** p. 2947, Vol. IV; also **Sclera, Melanosis of the**; as well as **Race.**

A case of extensive scleral pigmentation is reported by Smyth (*Oph. Year-Book,* p. 163, 1914). The pigment was irregularly distributed around two-thirds of the circumference of the cornea, being separated from the cornea by a zone of sclera 2 or 3 mm. wide. There was also an unusual amount of pigment in the iris. The patient was a young woman of 20. A single spot of pigment had first been noticed twelve years before.

Sclera, Protrusions of the. See **Ectasia of the sclera.**

Sclera, Rupture of the. The sclera may be ruptured as the result of the direct or indirect application of violent force. The line of rupture is generally found concentrically with the cornea, at a distance of two or three millimetres from the limbus, and is frequently situated above the horizontal meridian (Praun). The length of the rupture varies from three to twelve millimetres.

The principal work on this subject is that of Fuchs (Graefe's *Archiv f. Ophthalm.,* 79, I, 1910; abstract by Souter in *Oph. Review,* p. 311, Oct. 1911). The writer points out that diverse views are held as to whether the sclerotic ruptures from without inwards—(Müller), or from within outwards—(Fuchs). Wagenmann in the Graefe-Saemisch *Handbuch* says the point needs further elucidation. Fuchs details and discusses two cases of scleral rupture, which support his view that this begins at the ligamentum pectinatum, passes to Schlemm's canal and then outwards towards the surface.

Fuchs's first case was that of a woman, aged 62, who was found on examination two years after injury with a cow's horn to have, up-and-out, a hemp-seed sized, dark, somewhat lobulated swelling, separated from the corneal margin by 2mm. of dark, translucent

sclerotic. Cornea clear, iris absent opposite the ectasia, elsewhere smaller, posterior synechia below. Upper edge of lens tilted against back of cornea. T.n. Good p. l. and projection.

Microscopically—cornea flattened next the ectasia, which consists of thinned sclera with iris beneath. Inner scleral layers stop short at posterior edge of ectasia, here meridional fibres of ciliary muscle arise, in front the root of the iris, behind the ciliary processes. By the muscle the inner scleral layers are drawn back so that a space exists between them and the outer layers. This space is filled with new connective tissue. The outer scleral layers curve round to corneal edge. This part was filled out during life, corresponding to the 2 mm. dark band of sclera, but in the sections it is collapsed and folded. The thinned-out iris, with its posterior pigment layer partly detached covers almost continuously the inner surface of the ectasia. Sometimes only a few fibres thick of sclera remain, usually about one-third is ruptured. In rest of circumference iris is sometimes up against back of cornea and sometimes the angle is quite open.

No angle fibres are left, but from thickening of vitreous some strands are present.

The rest of eye is normal up to the neighborhood of the normal fovea, where, from the contusion, there are many cystic spaces, of various sizes, in the outer nuclear layer. Fuchs could find no evidence of total rupture of sclera but thinks there may have been a very small space by which aqueous had escaped. No signs of ligamentum pectinatum nor of Schlemm's canal, rupture having occurred through them.

Ectasia of the outer fibres between the torn ends of the inner fibres had occurred.

The second case, with more extensive rupture, was that of an eight-year-old girl, struck by a stone two months before, who showed a dark, translucent swelling around the whole nasal half of cornea, while in the cornea at the outer side was a short vertical scar with iris pigment in it. Cornea otherwise clear. Iris at inner side not visible, elsewhere iris small, adherent to cornea. Edge of lens seen; deep glaucoma cupping; no p.l., T + 2. Microscopically eye was cut vertically to include the upper—1 mm. broad—ectasia, and the lower—6 mm. broad. Cornea, therefore, uneven. *Above*—inner scleral layers end abruptly at back part of ectasia, and bend back, leaving a triangular space, as in the other case, filled with connective tissue. From this point forwards wall of globe is only outer scleral layers, expanded under the increased pressure. They have carried forwards the remnants of the wall of the torn canal of Schlemm. The torn scleral surface, the

new connective tissue and the back of ectasia sclera are all covered by the posterior pigment layer of the iris up to corneal margin. Part of the atrophic iris is adherent to cornea, pupillary part free. *Below*—sclera ends as above, but halfway along the ectasia is a swelling believed by Fuchs to be circular bundle of scleral fibres from just behind Schlemm's canal. The retinal layer of iris covers posterior surface of ectasia all along; and at anterior end of ectasia some iris stroma is present, with sphincter in it, adherent to back of actual corneal margin.

Fuchs thinks the ectasia is largely the result of the solution of continuity of the inner scleral layers but that it may become greater by the increased tension, due to destruction of Schlemm's canal and to the plastering of the iris up against back of the space. This may be the explanation of increased tension after some contusion cases. Other changes in the eye were choroido-retinitis, foveal thinning from atrophy; choroid and retina atrophied and fused around the deeply cupped disc.

In Fuchs's other preparations of scleral rupture he found several with inner layers alone ruptured, but none with outer layers only; and even in complete rupture cases he finds that the posterior torn end may be split into two layers, exactly as in the cases described.

Rupture of Schlemm's canal may be suspected, after a blow, in a case with much hyphema without iris rupture.

Between the split layers the connective tissue may later shrink and pull them together firmly again, but even in the presence of increased tension the muscle pulls the torn end backwards.

Between the torn ends of the inner lamellæ the root of the iris lies and the free part of the iris becomes smaller as in peripheral synechiæ in glaucoma. This recession or shrinking of the iris may be helpful.

Inner scleral rupture may be suspected if, after a blow without signs of perforation and after conjunctival effusion and swelling have gone, a blue-black line appears, near the corneal margin and concentric with it, and still more if here ectasia develops. Then comes recession or shrinking of the iris opposite the ectasia, giving distortion to the pupil there. There is usually some lens displacement.

Fuchs cites, from the wealth of his clinical experience, supporting cases, which did not come to the microscope.

In direct violence cases stretching is greatest on the inner scleral layers, hence they rupture first; while in indirect cases the sclera may give way at the site of a previous scleritis, signs of which may by their presence in the other eye give a clue.

Wachtler (*Woch. f. Ther. u. Hyg. des Auges,* June 12, 1913) reported

a large scleral rupture which was followed by normal vision. In the temporal portion there was a right angular rupture of all the ocular coats, one side measuring 10 mm., the other 15 mm.; also a 3 mm, gap, containing some vitreous. The wound edges, however, were fairly smooth and regular. The anterior chamber was filled with blood. Treatment—four scleral sutures, scopolamin, binoculus, ice-bag, sweats. The patient made an uneventful recovery and was discharged with 5/8 vision. Two years later vision was 5/5.

Arnold Knapp (*Archives of Ophthalm.,* Sept. 1913) gives the history of traumatic *equatorial rupture of the sclera* combined with division of the upper lid, caused by the patient striking the eye against a table when falling. When first seen the tension was normal and there was no indication of any rupture of the sclera. Ten days later a bluish, slightly raised area up and out and far back was observed. The eye was completely blind and as it was inflamed and sensitive, it was removed. Examination showed an open wound in the sclera just at the region concentric to the equator, about 10 mm. long and about 2 mm. posterior to the rectus externus insertion. The gap was filled with blood-stained tissue and contained a knuckle of retina which structure was completely detached. Knapp points out that the situation is a very unusual one for ruptures of the sclera due to indirect violence, and the preservation of normal tension with so large a rupture is noteworthy.

Brunetiére and Amalric (*La Clinique Ophtalm.,* May, 1917) illustrate their contention that enucleation should only be performed after thoughtful consideration by ophthalmic surgeons, and should not be advised by operators unskilled in this specialty, by a case report: A soldier was wounded by a shell fragment which penetrated the lids over the caruncle, splitting conjunctiva and sclera. Despite pressure and irrigation hemorrhage was so profuse that immediate intervention was called for. Hand movement was appreciated to a certain degree, so under general anesthesia a scleral suture was inserted which immediately stopped the blood flow. There was no escape of vitreous showing that the injury had only penetrated the outer layers of the choroid. The final result was a vision of 4/10 and the entire history proves, in the authors' opinion, that oculists are required even in the evacuation hospitals so as to be available early in the course of war injury.

Scleral spur. The name given to a circular bundle of fibres at the posterior end of Schlemm's canal.

Sclera, Sarcoma of the. W. T. Holmes Spicer (*Ophth. Review*, p. 28, Jan., 1908) describes an example of this very rare tumor in a man aged

49, who came with a swelling on the right eye. In June, 1904, he was working on a road, when a "spark" flew up and struck his right eye; there was slight bleeding at the time, and a little smarting, but nothing more was noticed until 6 months later, when his friends told him that there was a small black spot on the white part of the right eye at the outer side. This was at the place where the spark struck.

Situated on the bulb of the right eye 7 mm. behind the outer margin of the cornea was a conical, chocolate-brown protuberance, 5 mm. in height and 5 mm. diameter, which was hard and attached to the sclerotic beneath. There was superficial and deep hyperemia, and running backwards from the swelling were two ridges which appeared to be pleats in the conjunctival tissue in the neighborhood. There were no enlarged lymphatic glands; the fundus was normal and the vision $\frac{6}{6}$.

R. M. Nelson (*Journ. Am. Med. Assocn.*, June 7, 1913) also reports a case, as follows: E. W., colored Jamaican, aged 25, came late in October, 1906. Two years before, patient had noticed a feeling in left eye as if there was a piece of gravel in it, as also a small swelling or tumor. This tumor grew gradually until a month or more before patient came to the clinic, about which time the growth became much more rapid. When first seen the tumor was quite noticeable. Vision had been failing for the past four months. Pain had been neither pronounced nor frequent.

The tumor was located under the bulbar conjunctiva inferiorly, and thus was partly concealed by the lower eyelid. There were bluish spots over the tumor, evidently congested veins. On admission to the eye-ward of the hospital late in November, the tumor had either grown so in size or caused such swelling of the superimposed conjunctiva that a roll of the latter partly obscured was in contact with the cornea. Cervical lymph nodes of the left side were greatly enlarged. Clinical diagnosis made of malignant growth of sclera, probably sarcoma.

An enucleation of the tumor (and eye) was done in December. On laboratory examination the tumor proved to be a small round-cell sarcoma.

Nelson points out that there is a difference of opinion among writers as to the malignancy and proneness to recur of epibulbar sarcoma. Derby quotes both sides with seeming fairness. On the one side Strouse's statistics of twenty-four cases, with his conclusion that conservative measures, including primary abscission, are not contra-indicated. On the other hand Verhoeff and Loring, with the most complete statistics yet published of fifty-three primary abscissions, conclude that "after abscission the tumor sooner or later usually recurs and general metastases are not infrequent." Berry and Parsons, and apparently

Derby himself, are strongly inclined to the same belief as Verhoeff and Loring, and thus all favor enucleation of the affected eye, rather than abscission of the tumor.

Sclera, Staphyloma of the. See **Sclera, Ectasia of the**; also **Staphyloma of the sclera.**

Sclera, Stiffened. A name given to the ocular walls in glaucoma.

Sclera, Syphilis of the. This occurs invariably in the form of gumma (q. v.).

Sclera, Telangiectasis of. See **Sclera, Ectasia of the.**

Scleratitis. See **Scleritis.**

Sclera, Trephining of the. See under **Glaucoma.**

Sclera, Tubercle of the. Parsons thinks it is doubtful if primary tuberculosis of the sclera occurs, but that the coat is often secondarily involved—from tubercle of the uveal tract, cornea, Tenon's capsule, optic nerve and conjunctiva. Müller and Brailey have reported (each one) cases of claimed primary tubercle of the sclera.

Sclera, Tumors of the. True neoplasms of the sclerotic are exceedingly rare. In this *Encyclopedia* are mentioned or described sarcoma, various cysts, tuberculoma, osteoma, gumma, etc. A fibroma has been described by Saemisch. Noyes found of 137 epibulbar malignant tumors that 20 arose independently from the sclera. Secondary glioma, sarcoma and carcinoma are not so rare.

Sclera, Ulcer of the. This lesion occurs in suppuration of the sclera (See **Scleritis, Suppurative,** as well as **Sclera, Abscess of the**) but it is a rare condition. It is, however, found with glanders, metastasis, scrofula, etc., and as the result of the breaking down of tubercle or of a true tumor of the sclerotic.

Sclera, Wounds of the. See **Injuries of the eye**; as well as **Sclera, Rupture of the.**

Sclerectasia. (L.) Staphyloma or bulging of the sclera.

Sclerecto-iridectomy. The operation of excision of a portion of the sclera and of the iris for glaucoma (q. v.). Called also Lagrange operation.

Sclerectome. This instrument, for the operative relief of glaucoma in particular, bears a number of inventors' names. Most of the instruments are described under **Glaucoma** and **Trephine.** The device of Bardsley (*Trans. Ophthalm. Soc. U. K.*, Fasc. 3, 1912) is intended to simplify the operation of trephining. It is a compound instrument consisting of two parts, (1) a right-angled, narrow-bladed keratome with a hole drilled through the blade, (2) a punch attached to the handle of the keratome, which, worked by a lever and ratchet, descends into the hole. After making the usual conjunctival flap, the keratome

is passed into the anterior chamber through the sclera until the piece of sclera in front of the cut comes under the punch. The lever is then pressed and the punch removes a circular piece out of the sclera. The punched-out piece is removed along with the keratome blade—a very important point, since the risk of losing the disc in the anterior chamber is thereby abolished. A peripheral iridectomy can be done through the keratome opening.

Sclerectomia ab externo. This modification of the Lagrange sclerectomy is described by S. Foroni (*Archiv f. Ophthal.*, 89, p. 393, 1916) as follows: After injecting a few drops of novocain-adrenalin under the upper portion of the ocular conjunctiva, it is grasped with a toothed forceps, 1.50 cm. above the corneal limbus, and, by a von Graefe knife with the back toward the sclera a horizontal incision is made, forming a flap of 2.50 cm. long and 1 cm. high, which is carefully dissected down to the limbus. A scleral section is made near the limbus and parallel with it, the point of the knife being held vertically to the sclera. One mm. above this a second equal section is made and the circumcized piece of the sclera is cut off with scissors. The conjunctiva is sewed by a continuous suture, which remains for from seven to eight days. The writer performed this operation with good results in the different forms of glaucoma, keratoconus, detachment of the retina, and hydrophthalmos. He also used it with iridectomy in cases of total anterior synechia with complete abolition of the anterior chamber, and for optical purposes.

Foroni claims considerable advantages of his operation over those of Lagrange and Elliot. It is easier than the former, and the cleft made in the sclera gives a better access to the iris (if this has to be operated upon) and furnishes a larger area of filtration corresponding to the obliterated angle of the iris than the circular opening of Elliot. The decrease of tension is attained at once and is permanent. Foroni saw in no case early or late infection, or striped keratitis.

Sclerectomy. Although this caption was fully treated under the heading **Glaucoma** (q. v.) and the literature reviewed to the beginning of 1915 (since which date few advancements or improvements have been made in the instrumentation or other therapeutic conduct of the disease), yet it may be well to refer, in addition, to a few papers on this important subject. The reader is also referred in this connection to the headings **Trephining**; as well as to **Trephine,** and **Sclerectome.**

Brettremieux's essay (*La Clinique Ophtal.*, Dec., 1908) on the *action of simple sclerectomy on the blood circulation of the eye* has been reviewed in the *Oph. Record.* To the present time sclerectomy has been

regarded as favoring the excretion of the intra-ocular fluids by the creation of either a filtrating cicatrix or of a fistula, but Bettremieux believes that it has an action on the circulation of the blood in the eye. In the course of the operation of simple sclerectomy, after the dissection of the conjunctiva, the eye being under the influence of adrenalin, the operative field represented by the surface of the sclerotic is ordinarily bloodless; after the removal of several shavings of the sclerotic, there is tangentially to the limbus a surface of about two millimeters broad by six to eight long which is the seat of a sanguineous oozing, the deeper vessels having been opened; the conjunctival sutures which complete the operation place this refreshed zone of sclerotic in contact with the conjunctival and subconjunctival vascular network and thus vascular anastomoses are formed at this level.

In some cases of interference with the intra-ocular circulation we see the anterior ciliary veins much swollen, and we are following the indication thus given by Nature when we endeavor to promote the collateral circulation.

Bettremieux points out that simple sclerectomy presents some analogy with the operation of Talma, which consists in preventing the interference with the circulation in atrophic cirrhosis by creating adherences between the omentum and the abdominal wall and consequently favoring the establishment of a collateral circulation more important than that wihch normally exists between the veins of the portal system and the vena cava.

We sometimes see a burn of the limbus followed by passing glaucomatous phenomena; in such cases there has been an obstacle to the circulation by the destruction or compression of vessels; wherefore it seemed logical to try and cure glaucoma by ameliorating the pericorneal circulation of the eye by creating, as by simple sclerectomy, anastomoses between deep vessels of the sclerotic and the conjunctival and subconjunctival vascular network. In this way Bettremieux thinks that simple sclerectomy should aid the circulation of the blood in the eye, and consequently stimulate the nutritive processes, and he thus accounts for its beneficial action in certain cases of glaucoma, opacities of the vitreous, detachment of the retina and keratitis.

Bachstez (*Zeitschr. für Augenheilk.*, Jan., 1914; abstract in *Ophthalmoscope*, p. 674, Nov., 1914) presents us with the results of the microscopical examination of three eyes which had been operated upon for glaucoma. A Lagrange sclerectomy had been performed upon one, an Elliot trephining upon another, and a double trephining upon the third.

The Lagrange operation left a large cavity in the sclera, which com-

municated freely with the anterior chamber by a long canal. The conjunctiva was edematous but not raised up. The specimen was obtained fifteen days after the operation, the patient dying of pneumonia.

Another eye was removed sixty days after an Elliot's trephining operation. The scleral defect was filled with cicatricial tissue rich in cells. Delicate canals, which were lined with endothelium, were present in this tissue. The conjunctiva showed overgrowth of connective tissue and was somewhat edematous. Schlemm's canal had been freely opened by the trephining.

The last eye had been trephined three times, and in each case the wound had cicatrized firmly and the operation was a failure.

The plate attached to the communication shows a section through the site of one of these unsuccessful operations. A similar section was shown by Elliot himself at the Oxford Ophthalmological Congress in 1913, and illustrates a condition which unfortunately not infrequently follows these operations, whether performed with the trephine or the punch. The plate also illustrates the successful Lagrange fistula.

The author states that very few of these cases have been examined microscopically, and mentions a few examples from German literature. He makes no reference to several cases which have been published in England and shown at the last Oxford Congress and elsewhere.

An important review of an important paper on the *guiding principles in performing a sclerectomy* is R. H. Elliot's (*Lancet,* October 3rd, 1914; review by Ernest Thomson in the *Ophthalmoscope,* p. 43, Jan., 1915).

This paper was intended to be read at the postponed Petrograd Congress.

The writer begins by sweeping away the fine distinctions between "true filtering scars" and "fistulous scars," and clears the ground by declaring that we fail in our purpose if we fail to establish fistulization. We must aim at the establishment of a permanent subconjunctival fistula.

In order to secure such permanent fistulization we must have (1) asepsis, (2) a suitably-sized channel according to the needs of the case, (3) avoidance of entanglement of uveal tissue in the wound, either at the operation or later on. Failure of asepsis leads to formation of proliferative tissue in the trephine hole. A suitable-sized channel is to be obtained by using always a 2 mm. trephine and cutting off more or less of the disc of tissue marked out by it. The risk of impaction of uveal tissue in the wound is minimized by placing the trephine hole as far forward as possible. By the author's technique the trephined disc, hinged on its scleral side, can be dealt with according to

the exigencies of the individual situation. No matter how much or how little of it we remove, the fistula formed lies on the corneal side of the wound, and all the tissue left remains interposed between the angle of the chamber and the inner opening of the fistula, thus removing the latter as far as possible from the neighborhood whence danger may be feared.

The iris should be dealt with at the same time as the disc, both being divided with a single snip of the scissors. The great advantage of this procedure is that the eye is steadied by the forceps gripping the disc, so preventing an accident to the iris in rotation of the eye before the iris has been cut.

The author next demolishes the bogey of the "vesicular scar," which is said to mean limited filtration. The prominent vesicular scar is a product of faulty workmanship. It does not occur, and, on the other hand, an extensive filtration area is established, if the flap of conjunctiva is (1) correct in form, (2) large in size, and (3) correct in the method of its preparation. With regard to these points the author's insistence on a large flap concentric with the limbus and at some distance from it is well known. The correct dissection of the flap, thin above, thick below, and actually bareing the sclera next the cornea, while at the same time leaving as much tissue as possible at the sides undissected, is also well-known. See **Glaucoma.** The last stage of the formation of the flap is the "splitting" of the cornea. Such flaps as the author describes are apt to fall into place without any stitches being required.

Post-operative iritis is next discussed. Quiet iritis is liable to take place in this as in other operations for the relief of tension. By the free use of atropin from the second or third day this kind of iritis can be reduced to the rank of an inconvenience. (The reviewer gathers that the writer holds that such iritis is not septic in character.) Apart from the type of quiet iritis, we may have a continuation of, or an exacerbation of, an acute or subacute condition which existed prior to the operation. "A careful survey of such cases suggests the idea that we have to do with a septic action which was in existence before the operation, and which is, for the present at least, beyond the operator's control. It is probable that toxicity, possibly in many forms, is playing no unimportant part in the pathogenesis of some at least of the conditions which we now, for convenience sake, are content to group together under the one label of 'glaucoma,' guided, as we are, by the one central and dominating feature of a rise in intraocular tension." Septic contamination at the time of the operation should be a very rare event indeed.

With regard to late infections, about which a good deal has been heard lately, these, Elliot points out, are not peculiar to his method of doing sclerectomy. In any case, there is yet much to learn about the technique of this recent operation. He suggests two conditions which may pave the way for the occurrence of late infection. These are: (1) The persistence of a leaking fistulette somewhere along the line of the original conjunctival incision. This can be speedily closed by touching with 2 per cent. silver nitrate solution. (2) The presence of a thin vesicular filtration scar. As has been said, this should not occur with correct workmanship. Lastly, in this connection, Elliot demands that we should impress on our trephined patients the risks of injuries or of conjunctival infections. See, in particular, under **Trephining.**

Morax and Fourrière (*Annales d'Oculistique,* May, 1914; abstracted by Coulter, *Ophthalmoscope*, p. 38, Jan., 1915) have examined critically the results of the surgical treatment of chronic glaucoma, subacute glaucoma, and simple glaucoma at the Lariboisière hospital during the past eight years. They have already dealt with the results obtained in acute glaucoma, and propose to study those in secondary glaucoma in a future article.

The cases on which the article is based number 77, of which 37 occurred in males and 40 in females, while in acute glaucoma 47 out of 56 cases occurred in females. The age of the patients varied from 30 to 75 years, but 57 out of the 77 cases occurred between the ages of 50 and 70. The disease was bilateral in all but 14 cases, and even in these latter it could not be definitely stated that the second eye remained permanently unaffected. As a rule, local anesthesia (instillations of novocain and cocain, with subconjunctival injections of cocain) was found to be sufficient; but when the eye showed manifest symptoms of irritability, an orbital injection of cocain was added, and 14 out of 100 operations were done under chloroform anesthesia. The operations performed were iridectomy on 23 eyes, and sclerecto-iridectomy on 83. No remarks are made on the technique of iridectomy. In the earlier operations sclerecto-iridectomy was performed by Lagrange's method; but later, owing to the danger of rather large incisions with a Graefe knife, Holth's modification was adopted, and, finally, after May, 1912, a certain number of cases were trephined "following the technique of Freeland Fergus and Elliot." The immediate complications recorded were: (1) loss of vitreous one case (due to too large a scleral incision, eye saved with V. 5/38 and filtering cicatrix); (2) expulsion of lens with loss of vitreous in eye with tension 82 mm. Hg. Result, eye blind with T. 35 mm. Hg.; (3) expulsive

hemorrhage with atrophy of globe. The second eye of this patient developed glaucoma, which was treated by iridectomy; but the tension remained high, and there was an intra-ocular hemorrhage which reduced the vision to counting fingers. A posterior sclerotomy was performed, and the hemorrhage cleared up, leaving V. 5/5. For three years the vision varied between 5/5 and 5/7.5, and the tension between 25 mm. and 32 mm. Hg., but, in spite of the use of myotics, the tension then rose to 57 mm. Hg., and the sight became misty. A trephine operation was performed, with the result that a cystoid scar formed, the tension was reduced to 6 mm., and the vision became normal. Eighteen months later, the vision was normal, the tension was 22 mm. Hg., and there was no sign of obliteration of the cystoid cicatrix.

The post-operative complications are divided into early and late. The former comprised one inversion of the conjunctival flap, one hyphema lasting twenty days, one hyphema occurring on the seventeenth day, and some cases of unusual degree of pain. Sclerecto-iridectomy is frequently followed by severer pain than is usual in other intraocular operations, and a series of cases was watched, with a view to making a comparison between the amount of pain caused by the various methods of performing it, with the following result.—In fifteen typical Lagrange operations there was only one with exceptional pain, but this persisted for several weeks. In seven Holth operations six were quite painless, but the seventh had some pain on the third day, which quickly passed off. In twenty-four trephine operations pain was noted in ten cases, often sufficiently severe to prevent sleep on the night following the operation, in spite of the exhibition of acetyl-salicylic acid. This usually ceased on the day after the operation, and never lasted longer than the second day.

The late complications apart from return of tension, were.—(1) Late infection of the fistulous opening in two cases, one with incarceration of iris in the angle of the wound after a large iridectomy, an attempt having been made to remove a scleral wedge, which was unsuccessful owing to blunt scissors, and the other after trephining; (2) Late hemorrhage in the vitreous, two cases; one three months and the other twelve-and-a-half months after the operation. Both recovered with satisfactory vision. (3) Post-operative opacification of the center of the cornea, one case. The re-establishment of the anterior chamber after sclerecto-iridectomy took place after periods varying from one to sixteen days, but on the whole, it was slower after trephining than after Lagrange's or Holth's operation. The authors consider that slowness in the re-establishment of the anterior chamber is of good prog-

nosis for the formation of a cystoid cicatrix and its favorable action on the tension. The effect of the various operations on the tension was as follows: (1) Iridectomy.—Hypertension returned more or less rapidly in the greater number of the twenty-three cases. In five cases in which tonometric examinations were made, three had hypertension while in the other two there were small incarcerations of the iris causing cystoid cicatrices. (2) Lagrange-Holth operations.—In twenty-two out of twenty-four cases observed tonometrically the tension remained below 27 mm. and in several instances it was low one or even two years after operation. (3) Trephining.—In seventeen out of twenty-one cases, the tension was between 14 mm. and 25 mm. Hg. from four to eight months after the operation. It was found that in some cases the filtration persisted for years, while in others it ceased much sooner. When a fistula is going to disappear, it first widens, then becomes flat, and finally all trace of supplementary vascularization disappears. Although the presence of scleral fistulization coincided in some cases with a return of the tension to normal, there were other cases in which hypertension persisted or returned in spite of the existence of a cystoid cicatrix.

The results with regard to central vision obtained by both the Lagrange operation and trephining in cases under observation were satisfactory. Some patients had a reduction of from 1/10 to 2/10 in vision, while others had a notable and permanent improvement. The rapid and permanent loss which used to be dreaded in patients with very contracted visual fields was never experienced, although operations were performed on a number of such cases. In spite of the difficulty in following patients long enough to get reliable statistics and the notoriously deceptive nature of the results of treatment in chronic glaucoma, the authors consider that they are justified in concluding that the addition of scleral resection to iridectomy, and the consequent creation of a fistulous cicatrix, has manifestly improved the results obtained in the treatment of the disease, and that in spite of the operation and post-operative complications to which the operation is liable, it is fortunate that we possess a means of relieving for a longer or shorter time the grave functional trouble due to hypertension.

A review of *several forms of sclerectomy in glaucoma* is also given by K. G. Ploman (*Svenska Läkaresällskapets Handlingar,* p. 1, Vol. 42, 1916; review by W. H. Crisp, *Annals of Ophthalm.,* p. 807, Oct., 1916). An opinion as to the permanency of results cannot be given earlier than one year after operation, says Ploman. His essay reviews clinical material as follows: (a) Sclerectomy according to Holth: sixty-eight cases of primary glaucoma in fifty-five patients and one case of

hydrophthalmus; three cases of absolute glaucoma and one case of hydrophthalmus led to enucleation and the rest were observed from one to five years after operation, the average being three years. (b) Trephining: fifteen cases of primary glaucoma in eleven patients and one case of hypdrophthalmus; two cases of simple glaucoma and one of absolute glaucoma led to enucleation; the remainder were observed for from one to two and one-half years. From the point of view of complications, the study further included twenty-one cases operated upon according to Holth and forty-six according to Elliot; these cases were in the main only observed for a short time after operation.

Holth's sclerectomy.—In forty-one cases out of sixty-three (excluding absolute glaucoma), the tension was regulated. Of four cases of acute glaucoma three were successful, including one in which iridectomy had previously been without effect. Of four cases of chronic inflammatory glaucoma two were successful, two sclerectomies being done in each case. Out of sixty-five cases of glaucoma simplex, thirty-six were successful, two operations being performed in each of the three cases. Of the complete series of cases mentioned here, in five of the successful and two of the unsuccessful, iridectomy had previously been done without success.

In five cases of absolute glaucoma one good result was obtained, in one there was renewed rise of tension, and in three renewed rise of tension and pain, with consequent enucleation. In the case of hydrophthalmus two sclerectomies were without result; after the second operation a staphylomatous scar led to enucleation.

Regulation of tension was usually obtained immediately after operation, but in one case not until after five months.

The following figures show the value of iridectomy with sclerectomy. A renewed rise of tension developed after sclerectomy with peripheral iridectomy in seven cases, or thirty-three and one-third per cent.; after simple sclerectomy in seventeen cases, or fifty per cent.; after sclerectomy following previous iridectomy, in two cases, or 28.6 per cent.

Regulation of the tension was usually followed by preservation or improvement of function, but exceptions to this rule were encountered. Although twelve cases showed a tension of less than fifteen millimeters, in no instance could an injurious influence be attributed to subnormal tension.

Complications.—In ninety-six operations executed on eighty-nine cases of primary glaucoma and one case of hydrophthalmus, fenestration (?) occurred twice, iridodialysis four times, loss of vitroeus three times, traumatic cataract once; the anterior chamber was usually re-

stored on the second day, but in some cases only on the fourth to the tenth day. Serous choroidal detachment was observed twice. Postoperative iritis occurred in 26.7 per cent. of the cases, in 11.6 per cent. developing promptly after the operation, and in 15.1 per cent. later. There was no case of late infection. Nine cases of secondary prolapse of the iris were observed (after simple sclerectomy).

The writer divides the scars into three groups: flat scars, scars with conjunctival cushion, and ectatic scars, these last including uveal prolapse as well as ectatic hypertrophic connective tissue scars. The condition of the scars after sixty-nine operations is stated; a conjunctival cushion formed in thirty-six; an increase of tension developed after two of these operations; flat scars twenty-eight; a rise of tension developed after nineteen of these; ectatic scars were seen in five cases, in all of which a rise of tension subsequently developed. Iridectomy facilitates development of the conjunctival cushion. In six cases the cushion disappeared, the increase of tension recurring; in two of these the cushion later reappeared, and the tension in these cases was thereafter constantly low.

Microscopic examination was done on three cases of absolute glaucoma, one case of hydrophthalmus, and one case of secondary glaucoma. In these cases the healing seems to have originated from the subconjunctiva or episclera, not from the sclera or uvea. In two cases the uvea blocked the operative wound, in three operations the ciliary body was wounded by the lance, after one operation an ectatic hypertrophic connective tissue scar had developed, and in one case the lens was injured.

Elliot's operation.—Only thirteen cases could be completely followed longer than one year. To these may be added three which led to enucleation. The sixteen cases included two of acute glaucoma, twelve of simple glaucoma, one of absolute glaucoma, and one of hydrophthalmus. In eleven cases the result was good; in one case of glaucoma simplex rise of tension led to a second trephining; two eyes were enucleated because of rise of tension and pain, and enucleation was done in a case of absolute glaucoma for the same reasons. In the case of hydrophthalmus a large scleral staphyloma developed. On cases of primary, not absolute, glaucoma, fifteen trephinings were done successfully in eleven cases. Comparison of these with the figures as given by other writers shows that in cases of primary, not absolute, glaucoma, trephining is followed by a lowering of tension in from seventy to ninety per cent. of the cases.

Trephining should be combined with iridectomy; which, according to the experience gained so far, is to be done preferably in the form

of a peripheral iridectomy rather than a complete, since the former has equal value and is technically easier.

As regards complications, the seventeen operations already mentioned were available, and in part a further forty-seven operations on forty-six eyes (one acute glaucoma, four chronic inflammatory glaucoma, thirty-nine simple glaucoma). Twice a trephined disc fell into the anterior chamber, without anything further being noticed of it. In one case of absolute glaucoma it was impossible to replace the iris after complete iridectomy; the tension was thirty millimeters one month later. Re-establishment of the anterior chamber followed in twenty-eight cases on the second day, in twenty-four cases on the fourth to the sixteenth day. No disadvantage seemed to follow delayed re-establishment, with the exception of one case of iridocyclitis and rise of tension with re-establishment on the ninth day (later enucleation), and of one case of iritis with seclusio pupillæ with re-establishment on the fourteenth day (later tension 13).

Serous choroidal detachment was seen in nine cases, in all of which peripheral iridectomy had been performed. Secondary iris prolapse was seen in four cases, two after simple sclerectomy, one after peripheral iridectomy, one after radial incision into the root of the iris; in one of these cases the tension rose, but fell after cutting off the prolapse. Mild post-operative iritis developed in sixteen cases, and more severe iritis with seclusio pupillæ in two cases, one of which recovered, while in the other the eye was enucleated.

The author collected the hitherto published cases of so-called late infection, to the total number of sixty; six after Holth's operation, nine after Lagrange's, and the remainder after Elliot's operation. The conjunctival cushion appears to be particularly vulnerable to late infection: in twenty-three out of the twenty-seven cases in which the appearance of the scar is described, there was a cushion. The result of this complication was noted in forty-six cases. In fifteen it was good, in ten there developed lowered visual acuity or rise of tension, and in not less than twenty-one the patient lost either the sight or the eye. As regards this complication, no particular procedure seems to have any preventive value.

Two cases were examined microscopically after the Elliot operation. In one of them, a case of glaucoma simplex, enucleation was done on account of rise of tension and iridocyclitis rather more than one month after the operation. The trephine hole was correctly placed, but the ciliary body had been injured at operation. In the second case, one of secondary absolute glaucoma, enucleation was done on account of rise of tension and pain. There was a markedly bulging scar with free

communication between the anterior chamber and the cavity in the scar tissue. The ciliary body was exposed and rotated into the opening.

As regards the technic of the Elliot operation, the author favors a large conjunctival flap which does not extend to the limbus; regards splitting of the cornea as unnecessary, provided the operation is done higher up and that a one and one-half millimeter trephine is employed (in support of which contention he adduces investigations by various writers as to the depth of the angle of the anterior chamber). He inclines the trephine somewhat towards the cornea; carefully separates the trephine disc before making the iridectomy, and before doing the iridectomy also makes a small hole in the iris through which the aqueous humor can escape slowly. He sutures the conjunctival flap.

Concluding, it is stated that on account of the danger of late infection the author shares the views of Axenfeld, Butler and others, that great caution should be exercised in employing sclerectomy. Prophylactic sclerectomy is objectionable under all circumstances. In acute glaucoma sclerectomy is inferior to iridectomy, and should only be considered when this and possibly other measures have proved to be unsuccessful; the same is true as regards absolute glaucoma. In hemorrhagic glaucoma trephining may be considered on account of the possiblities of obtaining a gradual reduction of tension. Sclerectomy is indispensable in those cases of chronic glaucoma which are uninfluenced by other operative methods, or where no prospect of success by such methods appears to exist. In chronic glaucoma, with limitation of the visual field almost to the fixation point, sclerectomy with peripheral iridectomy is perhaps to be preferred to simple iridectomy.

W. R. Parker (*Arch. Ophthal.*, I, Jan., 1917), gives the *comparative results in a series of 71 trephine operations and 47 iridectomies.* In the trephine cases, a previous iridectomy was done in 11 cases, a complete in 31, a partial in 15, and the iris left intact in 16. In the 11 cases in which a previous iridectomy was done, iritis followed in 18.1 per cent. In the 31 caess, with complete iridectomy, iritis occurred in 16.1 per cent. In 15 cases, with partial iridectomy, iritis followed in 46.6 per cent. In 16 cases in which no iridectomy was made, iritis followed in 50 per cent. The percentage of good results in simple glaucoma was 60.9 per cent. All of the cases in which the remote results remained good were of the chronic non-inflammatory type. The 47 cases operated by iridectomy were selected as being best suited for that operation. Early results gave 72.2 per cent. good, in simple glaucoma, 75 per cent. good in chronic inflammatory, and 65.3 per cent. good in all types except simple. Results are given in six cases tre-

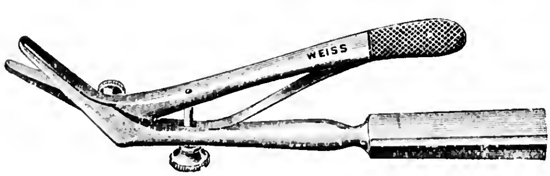
phined after iridectomy had failed. Of these the results were good in five and failure in one.

The writer believes that if 50 per cent. of the selected cases of simple glaucoma can be relieved by iridectomy and 50 per cent. of the remaining cases, by trephine operations, the results of 75 per cent. good would be better than most operators have been able to obtain. He also believes that deep iridectomy will be the operation of choice not only in the inflammatory cases but in selected cases of simple type, reserving the trephining operation for those cases in which the iridectomy is contraindicated or, having been performed, has failed to relieve the tension.

Finally, Bourdier (*Archives d'Ophtalmologie*, July, 1916), relates a curious experience of traumatic sclerectomy in the Great War. A soldier was wounded in the right eye and other parts of the head by fragments of shell and of wood. When examined twelve days after the injury, the right eye presented no inflammatory signs. V. = 0.4. Four mm. above the limbus, in the median line, was a perforation, of which the diameter was about 2 mm. There was no protrusion, but the uvea appeared in the aperture. Vitreous somewhat cloudy, and retina detached in the lower segment, opposite the perforation. No foreign body. A large iridectomy was performed, and the wound in the sclera covered with conjunctiva. V. twenty days later = I.

Sclerectomy punch. A number of these are described under **Glaucoma.** See, also, **Punch.**

The sclerectomy punch of John Hern (*Ophthalmoscope*, p. 148,



Lapersonne's Sclerectomy Punch.

March, 1914), consists of a handle (straight) measuring 3 in. to hinge of lever, and ¾ in. from the hinge of lever to the end of the lower or female blade; the lever is so hinged to the handle that when it is depressed, the upper or male blade is depressed into the lower, punching out a piece of tissue, which is held and can easily be removed by any pointed instrument passed into a fine fenestrum in this low blade.

According to the inventor, the advantages of this instrument over most of its kind appear to be:

1. The size of the piece of tissue punched out can be regulated by

the operator by using the screw adjustment, regulating the opening of the blades.

2. The lower blade is in a straight line with the handle. The operator can therefore always know its exact position, as it is also immobile.

3. The piece of tissue removed, is held firmly in the female or lower blade and cannot therefore be lost in the interior of the eye, as sometimes happens with the trephine.

Scleriasis. Same as scleroderma; also, any hardened state of an eye-lid.

Scleriasis palpebrarum. An old term for a cancerous disease of the eyelids; used later for any induration of the eyelids.

Scleriritome, Nicati's. A simple, narrow, double-bladed knife needle for the purpose indicated. See the figure.

Nicati's Scleriritome.

Scleriritomy. Incision of the sclera and iris in glaucoma (q. v.) and anterior staphyloma.

Scleritis. SCLEROTITIS. SCLERITIS IN GENERAL. Affections of the sclera belong to the class of uncommon ophthalmic diseases. The sclera is slow to take on inflammation, and, when once scleritis is inaugurated, recovery is slow, as might be expected from such a structure. Scleritis may be *superficial* or *deep, acute* or *chronic, diffuse* or *circumscribed.* Of the inflammations affecting this part, the most common is that known as episcleritis, in which the pathologic process involves the loose tissue over the sclera and possibly the superficial scleral layers also.

The superficial forms of scleritis (episcleritis) have been treated under **Episcleritis,** p. 4494, and under **Episcleritis partialis fugax,** p. 4498, Vol. VI of this *Encyclopedia.*

Scleritis (deep scleritis) is a much less frequent disease than episcleritis. It is a much more obscure disease, and in the early stages can be recognized with difficulty, since, in the absence of a microscopic section, it is impossible to say how deeply an episcleral inflammation has extended. Early in its history the presence of scleritis is to be inferred from the existence of complications, such as iritis, choroiditis, and sclerosing keratitis. As an interesting example of the acute type, mention may be made of the inflammatory thickening of the sclera which occurs in orbital cellulitis and panophthalmitis. The posterior scleritis which is found in myopia involves

the choroid, and is called posterior sclerochoroiditis. See **Choroiditis, Myopic,** p. 2155, Vol. III of this *Encyclopedia.*

As a result of inflammation, the sclera becomes softened. The normal or increased intra-ocular tension causes the membrane to bulge (ectasia of the sclera, q. v.). Scleritis tends to extend until the entire cornea has been circumscribed.

Early in its history scleritis presents a diffuse or circumscribed area of bluish-red or violaceous injection, situated in the ciliary region. Pain and lachrymation are prominent symptoms. The inflamed tissue resembles the patch of episcleritis, but is less sharply defined. When the acute process has subsided, the circumcorneal zone will appear of a violet color, resembling porcelain; if the sclera is much thinned, the affected area will be of a bluish tint, which is given to it by the subjacent choroid and ciliary body. Deep scleritis generally involves both eyes, and presents important complications (iritis, cyclitis, keratitis) which seriously impair vision.

Sclerosing keratitis.—In this affection, which is an accompanying symptom of scleritis, the corneal limbus is invaded by a dense opacity which creeps over it. Apparently the sclera has pushed its way into the cornea. See p. 6811, Vol. IX of this *Encyclopedia.*

Sclerokerato-iritis is the term applied to a complicated disease affecting the structures at the corneoscleral junction. It also is known as scrofulous scleritis, anterior uveitis, or anterior choroiditis. See p. 2140, Vol. III of this *Encyclopedia.* Relapses are common and the disease often is intractable. It begins with the clinical signs of an anterior scleritis; soon the cornea is affected and may go on to ulceration; the iris is involved and posterior synechiæ form. Under appropriate treatment the condition improves, but relapses often occur. Such cases often end in partial or total loss of vision from cyclitis and hyalitis. See, also, p. 3523, Vol. V of this *Enclyclopedia.*

Deep scleritis may be due to syphilis, scrofula, rheumatism, gout, or tuberculosis. It may result from exposure to cold. Gonorrhea, when associated with synovitis, is a cause. Disorders of menstruation are often present in females with deep scleritis. Sclerosing keratitis is sometimes found in adults who apparently are of robust constitution.

In the few unquestioned cases of scleritis which have been subjected to microscopic examination, a variety of changes has been found. In Baumgarten's case the sclera was thickened, measuring four millimetres, a condition which was due partly to an infiltration of small, round cells between the scleral bundles, partly to an increase in the number of fibres. In a case of old uveitis and scleritis Kostenitsch found abundant round-cell infiltration, numerous poly-

nuclear leucocytes, and small hemorrhages in the sclera, and an increase in the number of scleral cells and of blood-vessels. Edema and discoloration of the scleral fibres was noted by Schirmer. As a result of degenerative changes the sclera loses its resisting power. Under such circumstances the intra-ocular pressure may lead to the formation of ectasiæ. Atrophy does not always follow scleritis. The inflammation may result in proliferation, a formation of new tissue, and thickening of the membrane, with a formation of new blood-vessels. Since these changes are limited to that part of the sclera covering the ciliary body, and reach their greatest intensity at the points where the ciliary vessels pierce the sclerotic, it is reasonable to agree with Greeff, that deep scleritis is a secondary process, a consequence of a circumscribed uveitis which has extended along the sheaths of the vessels in the sclera. Gelatinous infiltration, purulent inflammation, and ulceration of the sclera have been recorded.

The treatment of deep scleritis includes the correction of any departure from health. In rheumatic cases the administration of salicylate of sodium, or aspirin, colchicum, salol, the alkalies, iodid of potassium, or of caffein, and the free use of water internally, will be appropriate measures. In scrofulous subjects a course of codliver-oil, with or without iodin and iron, will be in order. A change of climate will often be advisable. If tonics are indicated, iron, arsenic, and quinin should be given. In many cases diaphoresis is followed by improvement. The syphilitic cases will need salvarsan or mercury. The local use of atropin is of great importance, not only to draw the iris out of the way of harm, but to abolish accommodative effort. If the tension is increased, arecolin should replace atropin and repeated paracentesis of the anterior chamber must be resorted to, one or two drops of aqueous humor being evacuated every second or third day. The local use of moist or dry heat will be valuable to relieve pain. In some cases it will be necessary to give the patient a solution of holocain or of dionin to use whenever the pain is severe. When inflammation has subsided and has left the sclera weakened, the prolonged use of a mild miotic, combined with massage of the eye with a bland mercurial ointment, will serve to promote the absorption of the interfibrillary deposits. For the same purpose, thiosinamin (gr. ii or iij, three times a day), given in capsules, may be of value.—(J. M. B.)

Holmes Spicer (*British Med. Jour.*, Oct. 29, 1910), believes that there is no essential difference between episcleritis and scleritis save the variation in incidence with the time of life and the severity of the inflammation. So far as their connection with uveitis is concerned that depends upon the depth and intensity of the inflamma-

tion. He finds two types of scleral nodules—one hard and raised, which on incision proved to be mostly solid, though occasionally a bead of pus was found within. The second type presents a boggy, undermined condition; the surface blue, soft and yielding. Some cases began as a vesicular eruption. Considering sex and age incidence, he gave figures from 55 cases. Of these, 15, or 28 per cent., were in males; 40, or 72 per cent., females. The difference was striking.

As to the liability of the eyes to inflammation, the right appeared most frequently affected, but he thought there was little in the observation. The decades of maximum incidence proved to be between 20 and 40 years, but in considering this it had to be borne in mind that the duration of the cases was long—it might extend to 15 years. The features of corneal invasion were of interest. He noted the occurrence of crescentic areas of infiltration separated from the patch of scleritis by a band of clear cornea; these crescents had their concavity towards the limbus. When there were frequent attacks of scleritis in different parts of the eye, a complete ring of these small crescents might result, simulating *arcus senilis.* He thought they were due to obstructed lymph circulation in the cornea. He had observed similar crescents capping fascicular ulcers. The invasion of the inner parts of the eye was due to extension of the poison. Cyclitis, iritis, and opacities of the cornea were evidence of the severity of the inflammation.

As to etiology, he found evidence of rheumatism in 24 cases, and a definite absence of it in 26. Indigestion and constipation and pyorrhea alveolaris were exceedingly common in the affected, but were these not common in most hospital patients of this age and sex? The preponderance of females suggested the possibility of disease peculiar to female organs; but the most careful examination of many cases brought no evidence of this. The most certain thing was that the subjects were young women of sedentary habits—milliners, dressmakers, and the like.

Dealing with pathologic features, sections of nodules showed no evidence of tubercle; cultures were most often sterile. In one where the staphylococcus aureus was isolated a vaccine was prepared, but it proved useless. Von Pirquet's reaction was tried four times; two were positive and two negative. In the positive cases tuberculin injections were made; both recovered, though no striking changes in the scleritis appeared after the injections. Three cases were examined for syphilis by the Wassermann test, and all were negative.

As regards treatment, Spicer excised nodules in 9 cases with vary-

ing results; on the whole he thought well of it. He suggested incising the patch and touching it with carbolic acid. Injections of mercury cyanid had proved useless. Iridectomy had been done for secondary causes; in one case the scleritis recurred four months later; in another not for several years. Hot vapor baths were very good during attacks, but did not prevent recurrence. It was too early to estimate the value of ionization; he found the reaction severe. It tended to increase the severity of the attack, but one case appeared to be improved. He was inclined to consider it too painful. Salicylic ionization seemed much more pleasant. In his opinion, the disease was toxic, that is, not due to a local organism; and he based his opinion upon the absence of organisms in the nodules. He thought it was a local thrombosis, something like a chilblain, not that it was a cold weather disease or that warmth was a great factor in relief. It was a toxic thrombosis, and possibly the manifestation of tubercle in other parts of the body; yet it was not limited to tubercle. At present there were no means of distinguishing these toxins.

That tuberculosis is the main, and most probably the only etiologic factor in scleritis is the belief of E. Török (*Prac. Med. Series*, Eye, p. 69, 1911). He reports 15 cases, in 14 of which he used for diagnostic purposes subcutaneous injections according to the method of Enslin. Twelve of these gave a positive reaction; 5, a general; 7, a general and local. The local reaction was noticeable in the increase of injection, photophobia, pain, and in some cases the development of new small nodules. Tuberculin, T. R., was administered in 11 cases; in 10 a cure resulted, without a relapse in from 8 months to 4 years.

The writer concludes that tuberculosis is at least the most important etiologic factor in scleritis, chiefly in deep scleritis which is complicated with involvement of the cornea, iris and ciliary body and that rheumatism may have something to do with episcleritis.

Soulier (*Oph. Year-Book*, p. 163, 1914), states that while formerly rheumatism was given as the chief cause of scleritis and episcleritis, he believes that in disorders of the alimentary tract lies the chief causative factor. As proof he associates scleritis and erythema multiforme. Even where the scleritis occurs in tuberculosis, gonorrhea, angina, etc., he believes it is due to the slow absorption of toxins in the organism. Scleritis of gonorrhea and staphylococcus infections is generally of torpid or chronic form. Gilbert thinks that gout is a cause of scleritis. Tuberculosis of the sclera of probable primary origin was observed by Bell.

B. T. Lang (*Brit. Med. Jour.*, Feb. 22, 1913), points out that in the majority of cases of scleritis, keratitis, iritis, cyclitis and choroid-

itis, the cause of the affection is obscure. Excluding physical damage, the chemical effects of bacteria or other toxins are regarded as that cause. Bacteria cannot arise within the eye by a process of biogenesis; they or their toxins come from without, brought by the blood stream. Histological demonstration of the bacteria in the inflamed tissues is out of the question, because no eye is ever excised during the onset of the acute stage. Direct evidence is therefore unobtainable, and the views expressed are based on the evidences that have been obtained by treating the supposed source of the infection. Septic foci occur in three situations: 1. Along the respirato-alimentary tract. 2. Along the genito-urinary tract. 3. On the skin or in a sinus leading from it.

The views of the writer are based upon an analysis of 176 cases. He cites the histories of many chronic inflammatory diseases of the eye, all dependent upon infection influences. The areas of septic inflammation which give rise most often to eye troubles are those that are subjected to frequent mechanical disturbances such as infections of the gums, which are massaged at each meal, or the male urethra, which is continuously disturbed during micturation.

The histories of the cases cited in evidence are exceedingly interesting and seem to show without any doubt the frequent dependence of ocular inflammation, especially of the uveal tract, upon septic foci.

Patients, says Lang, often suffer from some chronic inflammatory lesion for years without ill effect; then perhaps after some minor ailment which reduces vitality, such as exposure, trauma, or a "cold," the eye will suddenly become inflamed. That such minor ailments are only the exciting, and not the predisposing cause, is shown by the fact that the eye remains inflamed long after they have ceased to act, while it recovers rapidly with the cleaning of the septic area. This is particularly noticeable after operations. Patients whose mouths are septic frequently take a long time to recover from such an operation as a cataract extraction. If, however, the septic focus is removed, the eye will recover rapidly.

He considers the argument that, whereas very many people have very septic mouths, very few have inflamed eyes, and that if there were any real connection between septic teeth and inflamed eyes many more eyes ought to be inflamed, as of little force, adding that whereas many men get gonorrhea, very few get gonorrheal arthritis. He suggests that senility of itself and myopia of itself do not cause choroiditis. The senile arteritis and the stretching of the choroid in myopia each tend to reduce the resistance of the choroidal tissues; he thinks that these are really cases of septic choroiditis occurring in

eyes that are in a weakened state, in support of which contention he points out how very much less choroiditis one sees in private patients with myopia than in hospital cases, and that senile central choroiditis is most frequently found in patients of the workhouse type.

In conclusion the writer says that it is in no way desired to suggest that it is necessary in every case to find out and treat a septic focus to cure the patient. Many cases of iritis and the like recover under the influence of ordinary treatment and the action of drugs, but such cases frequently recur unless the septic focus is treated. In cases of choroiditis it is necessary to treat the cause early in order to obtain any great recovery of vision. The object of this paper, and of the analysis of cases of which it chiefly consists, is to bring out the relationship of the patient's "general condition" to eye disease. Absolute proof that any one case recovered because one type of treatment was employed is impossible, and if his contentions were based upon but two or three cases that had recovered as the result of treating (or removing) the supposed septic cause, he should base no argument upon it. It is the fact that no fewer than 176 cases have been subjected to careful analysis, which emboldens him to maintain the views here expressed. He holds that eye conditions are often septic in origin and not due to anemia, idiopathic tendencies, rheumatism, or the gouty diathesis.

Scleritis, Annular. See **Scleritis, Brawny.**

Scleritis, Brawny. ANNULAR SCLERITIS (PARSONS). MASSIVE GRANULOMA OF THE SCLERA. GELATINOUS SCLERITIS. BRAWNY INFILTRATION OF THE SCLERA. In an essay on this subject Geo. S. Derby (*Archives of Ophthalm.*, I, 1916) states that, first, Baumgarten (1876) and then Schirmer described this disease, but that we are indebted especially to Schlodtmann (*Archiv f. Ophthalm.*, p. 56, Vol. 43, 1897) for a more definite clinical picture. Derby gives the following description of the affection. It usually appears as a gelatinous, brownish-red infiltration of the conjunctival, episcleral, and scleral tissues, most marked close to the limbus. The succulent swelling often overhangs the cornea and extends back a variable distance from the limbus, even to the equator and farther. In the diseased area there is enormous dilatation of the blood-vessels and lymphatics. Pain and tenderness are acute. As the process advances the cornea is involved in the form of a deep, interstitial opacity, always advancing until no clear tissue remains. This infiltration is accompanied by the formation of deep and also superficial blood-vessels. As the disease extends anteriorly, so also it penetrates into the deeper membranes of the eye, and almost invariably the uvea takes a greater or less part in the process. Syn-

echiæ, corneal precipitates, vitreous opacities, and even retinal separation may be found. The sight fails, pain becomes acute, and finally the globe comes to enucleation. The progress of the disease is characterized by its extreme chronicity and by its acute exacerbations and remissions.

Although the majority of cases reported are of the classic type first described by Schlodtmann, it is now recognized that the clinical picture may vary according to the severity of the process, and to the part of the eyeball principally affected. Thus, the changes may be most marked in the posterior half, as in the case of Wagenmann. The uveal involvement may be severe or nearly absent; the retina may show extreme changes with marked separation, as in Fleischer's case, or be comparatively little affected. Pain is usually a marked and distressing feature coming on in severe attacks. Tension is most often increased, but may be diminished, according to the stage in which the disease is seen. The red, succulent swelling is characteristic, but by no means always present, and in many cases the diagnosis is made only after enucleation has been performed. Again, in some instances, the early picture cannot be distinguished from that of anterior nodular scleritis.

The *prognosis* is grave, as the eye usually comes to enucleation on account of pain and loss of sight. In a large majority of cases but one eye has been affected; in three, however, the sight of both eyes was practically lost (Schlodtmann, Uhthoff, and Prochnow), while in two more (those of Verhoeff and Baumgarten) the second eye was mildly affected.

The *etiology* of this disease is still an open question. In the majority of cases no definite cause could be made out. There are but few definite facts to be found if we analyze the cases.

Gilbert believed gout to be the cause, as he found lesions of that disease elsewhere in his patient. Against his view it may be pointed out that in no other case have gouty manifestations been evident, that the pathologic examination of his case does not support his view, and that in the case reported examination of the blood for uric acid showed a normal content.

Bietti believed his case to be due to tuberculosis, and points to some suggestive features in the histologic examination to bear out his contention. In the discussion of Bietti's case Axenfeld was able, on the basis of a case of his own, not pathologically examined, to give some support to this view. Against tuberculosis, however, lies the evidence of all the other reported cases and that of the microscope. Tubercle bacilli, though sought for, have never been found, and in no case has a positive focal reaction to tuberculin been obtained.

The microscopic picture gives more support to a diagnosis of syphilis than to any other disease, and yet in only one case, that of Verhoeff, was the Wassermann reaction positive. The only evidence in favor of syphilis is the microscope, and that is inconclusive. A positive Wassermann reaction can be regarded as of little more importance in the diagnosis of a local lesion of this nature than is a general reaction to tuberculin without focal manifestation in the eye. The cause of brawny scleritis is still undetermined.

Basing statistics on the sixteen pathologically examined cases, we find the *age* of patients by decades is as follows:

Thirty to forty	2
Forty to fifty	2
Fifty to sixty	2
Sixty to seventy	4
Seventy to eighty	6

Thus, the average age of the sixteen cases is sixty-one and a half years. The oldest case is that of Verhoeff, seventy-six years; the youngest Derby, thirty-four years.

W. R. Parker (*Annals of Ophthalm.*, p. 275, April, 1913) reviews F. H. Verhoeff's article (*Ophthalmoscope*, Jan., 1913) based on a case occurring in a man aged 76, who for three years had occasional inflammation of his left eye for several weeks at a time. During the last few months the eye had been very painful at times. A positive Wassermann was obtained.

The left cornea was clear except for fine precipitates on its posterior surface. The bulbar conjunctiva and episcleral tissue were moderately congested and thickened all around the cornea. Above, there was a flattened quadrilateral swelling, yellowish in color, corresponding to the insertion of the superior rectus, and on the nasal side a similar swelling corresponding to the insertion of the internal rectus. The pupil, semidilated (atropin), showed no definite synechiæ. The lens was slightly cataractous, preventing a good view of the fundus, which, however, seemed normal. Tension slightly elevated. Vision of left eye, light perception only.

One month later the right eye became similarly involved. The episclera was moderately congested throughout, and showed two thickened areas at the sites of the superior and internal recti tendons. Otherwise the episclera was free from infiltration. In the zone of the perforating vessels above, the sclera showed a number of irregular, bluish, translucent areas, not elevated, the largest measuring about 3 mm. in diameter.

The left eye was enucleated. Pathologic examination showed two flattened quadrilateral nodules, each about 7 mm. in diameter, one corresponding to the tendinous insertion of the superior rectus, the other to that of the internal rectus. On section the sclera was seen to be greatly thickened, especially at the sites of these two nodules, where it presented a gelatinous appearance. The ciliary body and anterior part of the choroid were also greatly thickened all around and gelatinous in appearance. In places there was no line of demarkation between the ciliary body and sclera.

Histologically the essential changes consisted in an invasion of the anterior portion of the sclera and recti tendons with granulation tissue richly infiltrated with plasma cells, and diffuse plasma cell infiltration of the ciliary body and anterior part of the choroid. There were a few giant cells, and also areas of fatty degeneration infiltrated with pus cells and endothelial phagocytes, but no definite caseation. There were marked peri- and endarteritis.

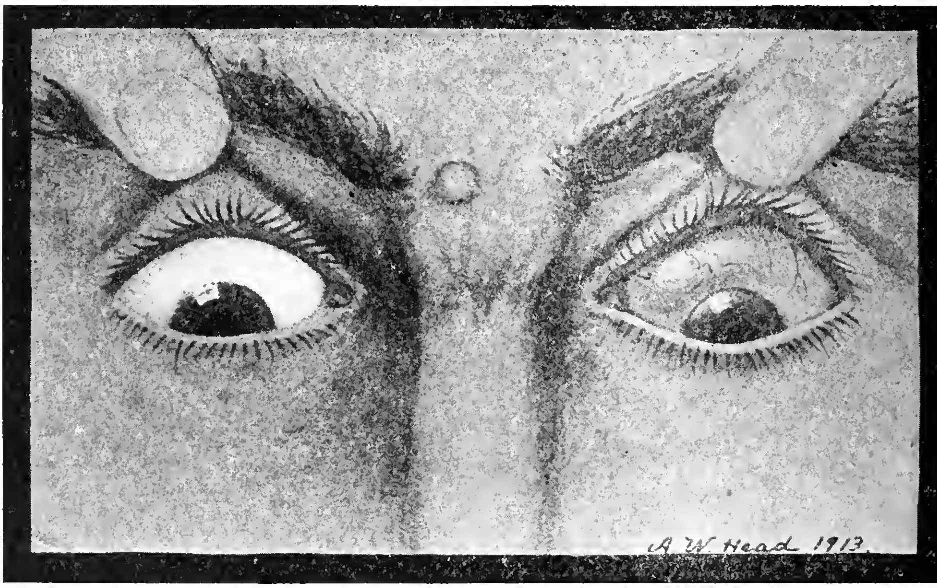
Verhoeff regards brawny scleritis as a distinct type of scleritis, differing essentially in both its clinical and histologic aspects from anterior nodular scleritis. Clinically it is characterized by the advanced age at which it occurs (usually over sixty), its insidious onset and extremely chronic course, and the diffuse congestion and thickening of the sclera and episclera without the formation of definite nodules. The infiltrated recti tendons, however, may simulate scleritis nodules. Ultimately the anterior part of the sclera becomes involved around its entire circumference, and the process also invades the cornea. Evidences of intraocular involvement, such as vitreous opacities and iritis, occur late and are relatively slight. Pain likewise does not occur until late. The intraocular pressure is normal or elevated. Both eyes are usually affected, although not always simultaneously, and the disease usually leads to blindness in one eye at least.

In the early stages there is a diffuse plasma cell infiltration of the sclera and episclera. Later on, possibly at the same time the sclera becomes pervaded by granulation tissue, the plasma cell infiltration increases and involves by continuity first the anterior part of the choroid and ciliary body, and, finally, the whole uvea. Necrosis of the granulation tissue takes place, showing itself as areas of purulent infiltration containing numerous endothelial phagocytes filled with fat, or as well-marked caseation. Giant cells may or may not be numerous. Peri- and endarteritis are marked in the affected tissues. Even in the advanced stages, where there is intense infiltration of the ciliary body, there is no formation of cyclitic membrane. Separation of the retina ultimately occurs, due to exudation of serum from the choroid.

The character of the lesions in brawny scleritis, the writer thinks, strongly indicates a syphilitic origin for the affection, but until such reactions have been obtained in a number of cases, or spirochetes have been demonstrated in the lesions, it cannot be regarded as absolutely established that brawny scleritis is a manifestation of such disease.

Holmes Spicer (*Oph. Review*, p. 384, Dec., 1913) had once shown a case under the title "solid edema of the conjunctiva," that had a syphilitic origin.

J. B. Lawford (*Proc. Royal Soc. of Med.*, Sec. of Ophthalm., March, 1914) gave a report on a typical case of chronic brawny scleritis. A



A Case of Unilateral Brawny Scleritis. (Stephenson.)

man of 70 years came on account of an eye inflamed for some three months, but without failure of sight. No material history. Wassermann test negative; differential blood count normal. During the three months the man remained under observation, the condition slowly became worse and a slight iritis developed. Treatment by large doses of potassium iodide apparently did no good. Microscopic examination of a portion of the swollen tissues showed merely the changes of an inflammatory process of a subacute type. There were many thin-walled blood-vessels, but no thickened vessels could be seen. The inflammatory cells were not arranged in follicles or nodules.

In depicting and describing this condition, Sydney Stephenson

(*Ophthalmoscope,* May, 1914) remarks that among rare diseases of the eye none is more striking than the first cases described by W. Schlodtmann. The disease occurred in three patients, aged 64, 74, and 74 years respectively, being bilateral in two instances.

Brawny scleritis, as described by Stephenson, is essentially a disease of middle life or old age, and affects men more often than women (Komoto). It runs an exceedingly chronic course, the even tenor of which is liable to be interrupted by exacerbations, as in Baumgarten's case, where attacks of pain, photophobia, lachrymation, and redness lasting for some twelve hours at a time came on about every month. Gilbert's case seems to be quite exceptional, since its course was very rapid, only a few weeks elapsing from the onset of the disease to removal of the affected eye.

That such eyes are only too often lost, although not from brawny scleritis pure and simple, is shown by the fact that pathologic reports of the condition are relatively numerous. More than one of the affected eyes has been removed under the idea that it contained a new growth.

Stephenson's case was seen within three weeks of the commencement of the inflammation, and although watched for many months, nothing of the kind was seen.

In Oatman's case, the patient, a man aged 54, presented in one eye the unusual feature of a staphyloma on the temporal side of the sclera. A severe blow upon the affected eyeball set up intense pain, and the globe and the staphyloma became soft and fluctuating. After enucleation, it was found that the staphyloma was constituted by an ectasia of the sclera, in conjunction with a dense cellular deposit involving the tendon of the external rectus muscle at its insertion into the sclera. The sclera was completely ruptured at that place, thereby accounting for the flaccidity of the globe noted after the injury to the eye.

In the further course of the disease, the infiltration spreads into the cornea, probably through the ligamentum pectinatum, where it takes the form of a so-called "sclerosing keratitis." The anterior segment of the uveal tract becomes compromised, although usually not until late in the history of the case. This renders it extremely probable, as surmised by Baumgarten, Uhthoff, Parsons, Komoto, and others, that the affection of the uveal tract is secondary to the scleritis. In Verhoeff's case, indeed, the fact that the sclera showed marked tissue proliferation, whereas the episclera and uvea showed chiefly plasma cell infiltration, is almost enough to prove that the scleral process was the primary and essential factor in the symptom-complex.

Clinically, implication of the anterior part of the uveal tract is shown by sclerosing keratitis, keratitis punctata, posterior synechiæ, occlusion of the pupil, vitreous opacities, and lowered tension.

Scleritis, Deep. SCLEROKERATITIS. See **Scleritis.**

Scleritis, Fugacious. See **Episcleritis partialis fugax,** p. 4498, Vol. VI of this *Encyclopedia.*

Scleritis, Gouty. See **Scleritis.**

Scleritis, Gummatous. See **Sclera, Gumma of the,** as well as **Scleritis.** Wilder has reported (*Oph. Year-Book,* p. 142, 1913) a case of gummatous scleritis in a woman 21 years of age, who had repeated attacks of inflammation of the left eye previous to having consulted him. A large yellowish hemispheric nodule 5 mm. in diameter was seen on the nasal side of the globe 7 mm. from the limbus. Pupil irregular from posterior synechiæ. Tuberculin test was positive, but inoculation of the eyes of two rabbits with a small particle taken from the growth was negative. Wassermann test was strongly positive.

Scleritis indurativa. This name was given by Stransky (*Oph. Year-Book,* p. 141, 1913) to the condition which the inventor believes is responsible for glaucoma simplex. He thinks the latter is not the result of increased tension, but is due to a *scleritis indurativa* leading to new formation of connective tissue and to increased scleral rigidity. The increased hardness of the globe in glaucoma simplex is, therefore, due to rigidity of the scleral covering, and not to any increase of intra-ocular tension. When the globe is palpated digitally or by instruments, two factors are under examination, namely, scleral rigidity and scleral tension. The summation of these two factors equals the bulbar resistance. Scleral tension is proportional to intra-ocular tension, but inversely proportional to the rigidity of the sclera. He further believes that if a hard eye exhibits increase of volume, there must exist increased tension. However, if a hard eye shows a decrease of volume, decreased tension exists and the eye is hard because of scleral rigidity. Only in the former instance is glaucomatous disease present. In the hard small eye is found scleritis indurativa.

Scleritis, Metastatic. For *metastatic abscess of the episclera,* see p. 7672, Vol. X of this *Encyclopedia.*

Dupuy-Dutemps and Lemarchal (*Annales d'Oculistique,* cxliv., July, 1910), describe a case of metastatic scleritis in a healthy lad of 19. [The article is reviewed by Souter (*Oph. Review,* Jan., 1911).] He had a slight edema of right lids, conjunctival injection and episcleritis of lower outer quadrant. Twenty-four hours' history: no pain. In two days the edema had gone, but the episcleral injection had increased, and a protuberance was noted on its surface. Vision was one-third.

The history and physical examination were against syphilis, but the appearance was so strongly suggestive of gumma that iodide of potash and intravenous injections of mercury cyanide were given vigorously. The inflammatory swelling continued. The absence of pain was very noteworthy in such a sudden, severe, episcleritis.

Two days later the uniformly red swelling was the size of a small hazel-nut, and prevented the lids from closing. It encroached on the cornea, and spread out to the outer cul-de-sac. Slight iritis appeared, and went away after a few days, leaving some pigment on the lens capsule. Vitreous was clear and the fundus normal.

Three weeks later anorexia, pallor and wasting were noted, and the aspect was typhoidal. Vague pain about the sacrum. One week later the patient was admitted to the surgical wards, and the specific treatment was stopped. Temperature 39 deg.; pulse, 120. Prostration, dry tongue, constipation. Micturition frequent, painless, but impossible in horizontal decubitus. Urine normal.

Two days later rectal examination revealed a large prostatic abscess, from which much creamy, non-fetid pus was obtained. Temperature was normal next day. The formation of this insidious prostatic abscess, in the absence of any past or present urethritis made one think of a blood origin for the anomalous episcleritis. Cultures of the prostatic pus yielded the staphylococcus aureus; and this organism was obtained pure from serous fluid removed by puncture from the raised episcleral area. Blood cultivations were negative on two occasions.

Two days later the temperature rose again, and pain developed in the right lower thorax, then a perinephric abscess formed, from which 300 cc. of pus, resembling that from the prostatic abscess, both macroscopically and culturally, were obtained. The cure was rapid and sustained.

The episcleral tumor had a very gradual onset and a very gradual resorption—no pus in it, no breaking down, no ulceration.

Three months from the start there was no redness, but still some swelling reaching to the cornea; but a slate color occupied its centre, which was more apparent now. This depressed area evidently corresponded to a part of the sclerotic attenuated by the inflammatory process, so that the color of the choroid showed through. Vision returned to normal.

In this case the primary focus was an insignificant infected wart on the right ring finger, which had caused a small superficial abscess, opened three days before the ocular troubles began. Its cure had been so simple and so speedy that attention was scarcely directed to it, and indeed the etiological relations between the finger sepsis and the iso-

lated eye condition would scarcely have been suspected, had not the other lesions developed.

In the less acute septicemias one can usually find the causal organism in the primary focus, even if the blood cultures are negative.

It would be interesting to know whether the slate color persisted, and for how long, as the reviewer had a case of metastatic ophthalmitis some time before—after a severe whitlow—where a similar slate-blue appearance was followed some months later by shrinkage of the globe, calling for enucleation.

Recent observations on staphylococcus eye infections are varied and interesting, and it is just possible that some of those cases of isolated choroiditis and retinal patches in patients where tubercle and lues may perhaps fairly reasonably be excluded, may really be due to small metastases which have undergone resorption without causing any general infection of the eye.

Scleritis, Posterior. Weeks (*Treatise on Diseases of the Eye,* p. 316) points out that these cases are rare and generally recognized only by histological examination. In one case, a boy of 16, which Fuchs described, there was deep-seated pain. The retina was found to be steel-colored and pushed forward at the macular region. Vision was much impaired but the patient recovered in a week. Fuchs attributed the condition to inflammatory swelling of the sclera that involved the overlying retina and choroid. In cases reported by Sulzer and Wagenmann the eye was enucleated because of suspected neoplasm. A tumor-like swelling of the sclera was found.

Scleritis, Rheumatic. The title includes both deep and superficial scleritis suspected to have often a (so called) "rheumatic" origin, in which case the treatment should be especially directed to the cause. See **Scleritis.**

Scleritis, Scrofulous. See **Keratitis, Sclerosing.**

Scleritis, Superficial. See **Episcleritis,** p. 4494, Vol. VI of this *Encyclopedia.*

Scleritis, Suppurative. Abscess of the sclera. This condition (see, also **Sclera, Abscess of the**) is generally due to trauma followed by infection. Strabismus operations and the entrance of foreign bodies, occasionally set up suppuration beginning from without. Internal causes are purulent choroiditis and panophthalmitis. Weeks observed a case resulting from metastatic purulent choroiditis, scleral suppuration and perforation at the equator. The infective point of origin was evidently the canal for the passage of the venæ vorticosæ.

Scleritis, Tuberculous. See, also, **Sclera, Tubercle of the.** Commenting on the fact that the etiology of scleritis is often obscure and

is generally held to be dependent upon a rheumatic diathesis. Verhoeff (*Boston Med. and Surg. Jour.*, March 14, 1907), made some observations in a series of cases which have convinced him that scleritis is almost always a tuberculous process, that tuberculous scleritis presents certain distinctive features, and that in cases in which the proper treatment can be carried out recovery may be confidently expected.

Although a considerable number of cases have now been reported in which tuberculin has been successfully used in the diagnosis and treatment of other forms of ocular tuberculosis, especially tuberculosis of the iris, cornea and conjunctiva, its use in cases of scleritis seems to have been almost entirely neglected, only a few cases having been reported in which both a general and local reaction were obtained.

The writer's observations were made in thirteen unselected cases of scleritis. The cases were all treated with subcutaneous injections of Koch's old tuberculin, and with the exception of two cases were all admitted to the hospital for this purpose. A positive general reaction was obtained in all cases and a local reaction in the eye in nine cases. Where the reaction was at all doubtful the injection was always repeated with a larger dose. The method finally adopted was to give an initial dose of 1 mg., then if necessary 1 mg., and finally 10 mg., at intervals of 48 hours; in most of the cases the reaction varied between 101° F. and 103° F. A local reaction was observed in nine cases and consisted in an increased chemosis and congestion of the affected region, and where keratitis was present sometimes in an increase in the corneal infiltration. Except in one recent case, the local reaction quickly subsided, leaving the eye more or less improved.

All of the patients were females; ages ranged between 11 and 46 years, average 26 years; with one exception the patients were well-nourished and apparently in good health, aside from the ocular trouble; in only three cases were evidences of the tuberculosis of the lungs or elsewhere made out. All the cases conformed to the classical description of anterior scleritis; in two the inflammation was more superficial and would have come under the classification of episcleritis. They all showed more or less definite nodules and thus presented what is sometimes distinguished as the nodular form of scleritis; during the subsidence of the affection, however, the diffuse form was often simulated, so that it is probable that there is no real distinction between the two forms.

The nodules of scleritis most often appear as elevated areas in the sclera, reaching a considerable size and situated some distance from the cornea. In addition to these, the writer noticed much smaller nodules varying from less than one to several millimeters in size, situ-

ated beneath the conjunctiva and forming the centers of small congested areas; these were almost perfectly translucent and usually occur in the vicinity of one of the larger elevations, sometimes near the limbus where they may be mistaken for phlyctenules. These small nodules have been noted by others; but attention has not hitherto been called to their chief peculiarity, namely, their tendency to appear and disappear within a short time, a week, for instance. The histologic examination of the nodules showed the essential lesion to be a focal proliferation of epithelioid cells, among which an original giant cell occurred, surrounded by an infiltration of lymphoid and plasma cells. The vessels in the neighborhood showed perivascular infiltration with chronic inflammatory cells and the subepithelial tissue a similar infiltration; caseation was absent; no tubercle bacilli were found, but it is notoriously difficult to find the bacilli even in very active lesions. Thus, with the exception of caseation, these nodules had the structure of small tubercles, and the writer now regards the occurrence of one of these small nodules in a case of scleritis as alone sufficiently conclusive evidence of the tuberculous nature of the process.

With one exception the hospital cases did poorly owing to the impossibility of supplying sufficient fresh air; in four cases it was possible to adopt more desirable measures owing to the favorable conditions under which they lived; the greatest possible amount of rest and nourishment and open air, day and night, and twice weekly injections of Koch's old tuberculin in slowly increasing doses as long as the eye did not react and there was no consequent rise in temperature; these four cases steadily gained in body weight and the ocular inflammation entirely subsided within six weeks to two montns.

The writer continues the report with a discussion of exacerbations during the menstrual period, the relationship between scleritis and systemic tuberculosis, the explanation of the origin and character of the lesions of scleritis as suggested by the recent experimental work of Stock, the relationship between the occurrence of scleritis and the prognosis of systemic tuberculosis, and further considerations regarding treatment, the tendency of scleritis to recur and the consequent necessity for continuing the treatment beyond the time of disappearance of the local signs. He has been so well satisfied with the results obtained with the old tuberculin that he has not considered it advisable to use the new tuberculin (tubercle bacilli emulsion), but he would not hesitate to use the latter in a case which did not respond well to the old tuberculin.

Chas. N. Spratt (*Journal-Lancet,* June 1, 1912) points out that after Koch's discovery in 1890 numerous cases of suspected tuberculous scleritis were treated by tuberculin.

For example, Wagner, in 1891, reported a case of scleritis, cured in six weeks by injections of tuberculin 1/200 to 3 mg. The patient gave both a general and a local reaction to tuberculin. A second case in which both a local and general reaction were obtained, is reported by Czermak in the discussion of von Hippel's paper.

Von Hippel, in 1904, reported a case of severe scleral tuberculosis and corneal nodes absorbed by injections of 1/500 to 1/5 mg. of tuberculin. Recurrence and cure followed after more injections. He did not state that a reaction was obtained. In the discussion of von Hippel's paper, Sattler reported treating two cases of episcleritis with tuberculin (T. R.).

Derby furnishes a report of 14 cases of sclerokeratitis treated with bouillon filtrate (B. F.). The maximum dose was from 7/1000 to 5 mg., and the number of injections 10 to 25. Ten of these gave a general, and seven a local, reaction to tuberculin. Six cases of kerato-iritis and nine cases of interstitial keratitis were also reported, in which tuberculin was used with satisfactory results. Two cases of the former group and four in the latter gave both general and local reactions.

Pratt believes that scleritis is probably always secondary. We know how frequently the tubercle bacillus may remain dormant in the body and suddenly light up a fresh focus. It is not unlikely that a tonsil or a bronchial gland may be the primary focus in many cases. Stock thinks that the disease is an extension from a metastatic focus in the uveal tract.

From the histologic finding in a case of tuberculous cyclitis, Verhoeff advances the theory that in scleritis, the infection reaches the sclera through the filtration-angle. "The infecting bacilli are derived chiefly from the superficial vessels of the ciliary processes, and are carried in the aqueous humor to the filtration angle. Whether there are always small initial foci on the surface of the ciliary processes, or whether the bacilli, contained probably in phagocytic cells, are exuded through the intact pars ciliaris retinæ, is uncertain. In tuberculous keratitis the infection is also from the aqueous humor, the cornea becoming infected either by metastasis or extension from foci about the filtration-angle, or from a preceding scleritis. Two forms of tuberculous cyclitis are to be distinguished, namely, the interstitial and the superficial. Interstitial cyclitis is usually secondary to scleritis, and due to direct extension of the latter. Superficial cyclitis occurs as a direct blood-metastasis. Clinically, it manifests itself as one of the forms of serous cyclitis."

Method of diagnosis.—The patient's temperature should be taken every two hours for one or two days. If there is no fever, one milli-

gram of old tuberculin is injected subcutaneously, the temperature still being taken every two hours. A general reaction is obtained if the temperature reaches 100.5° with malaise, chills, and redness and swelling about the point of injection. A local reaction is shown by increased injection of the conjunctival blood-vessels, lachrymation, photophobia, sensation of foreign body, and pain.

As sometimes the symptoms are severe a small initial dose is recommended. If there is no reaction, three days later two mg. tuberculin are injected. If again there is no reaction, the dose is increased to four, then six, and finally to ten milligrams, at intervals of three days, until constitutional symptoms occur and the temperature reaches 100.5°. A local reaction in the diseased eye is essential for a positive diagnosis. As to the safety of tuberculin as a diagnostic aid, all are agreed that in small cautiously increasing doses, it is practically without danger. Tinker has reported over 400 cases with no untoward results.

Treatment of tuberculous scleritis.—As in the treatment of other forms of tuberculosis, feeding, fresh air, rest, and injections of tuberculin are indicated. Local use of atropin, dionin, and fomentations are indicated.

It is still an open question as to which tuberculin is the best. Verhoeff used the old tuberculin (T. O.). Derby used in his cases the bacillus emulsion (B. E.). It is generally thought the emulsions (B. E.) or vaccines (T. R.) containing dead bacteria are less uniform in dosage, and are likely to cause more severe reactions than are the filtrates containing the soluble toxines, as Koch's old tuberculin (T. O.) and Denys' bouillon filtrate (B. F.). In the light of the recent report of the British Royal Commission on Tuberculosis, the human strain is preferable to the bovine, their finding being that the bovine type of tuberculosis is rare in human beings, except in intestinal tuberculosis in children.

Those who believe in the theory of specific bacterial immunity or vaccination, use the tuberculin in sufficient doses to cause slight reaction, at long intervals. In several cases an improvement in the eye condition followed the reaction produced by the diagnostic dose. This has been observed by others in eye tuberculosis, lupus, and tuberculous laryngitis. Verhoeff believes in causing slight reactions, as the patients are always in good health and the lesions show no tendency to caseation or ulceration. On the other hand, if the curative action of the tuberculin depends on an acquired immunity to the toxin of the tubercle bacillus, a reaction is to be avoided, as it is an evidence of intolerance, and no immunity is produced. This latter theory is the one more generally accepted.

Scleritis, Ulcerous. Quite apart from ordinary scleral ulcer and its association with suppurative scleritis discussed in this *Encyclopedia*, Henning Ronne (*Ophthalmoscope*, June, 1911) believes that there is a typical, "recidivating, nodular, rheumatic scleritis and episcleritis with formation of ulceration." He has found such a case mentioned by Hirschberg (*Klin. Beobact.* p. 30, 1874) as well as a report of another by himself (*Klin., Monatsbl. für Augenheilk.*, Mar., 1908).

He describes a third case in a woman aged 35. One of her sisters died of tuberculosis. In March, 1909, the present disease commenced by scleral injection; a yellow spot formed in the injected part, and a right-sided scleritis. She was treated with aspirin, cocain and atropin as well as with massage, and shortly after she was much better. Later she returned with the pupil maximally dilated (atropin); a few synechiæ downward. At the upper corneal margin was a rather extended episcleral infiltration, 15 mm. in breadth, 12 in height. In the infiltrated area were yellowish nodes, 4 lateral, deep and with the conjunctiva over them, besides 2 nasal nodes adherent to the conjunctiva and distinctly superficially ulcerated. At the bottom the ulceration was filled with a yellowish necrotic mass. The bottom was distinctly colored by fluorescein. The ulcerations were quite superficial, not craterformed; the cornea in the neighborhood was slightly diffusely parenchymatous. There were no visible opacities in the vitreous, but the fundus was slightly veiled, a condition insufficiently explained by the dimness of the cornea or by the numerous pigment deposits on the anterior lens-capsule. V. was 5/xxiv.

After several minor relapses the patient left before complete recovery, but sufficiently well to suggest to the writer that the characteristic picture of ulcerous scleritis includes local necrotic ulcerations accompanying a scleritis of the rheumatic type which on healing leave a slate-colored cicatrix.

Sclerocataracta. (L.) A hard cataract.

Sclero-choriotomy. An operation for glaucoma. See p. 5544, Vol. VII of this *Encyclopedia*.

Querenghi (*Oph. Year-Book*, p. 213, 1909) treated 43 cases (54 eyes) of acute and chronic glaucoma by sclerochoriotomy with a good result in 40. The operation, as he performed it, consists in the introduction of a small Graefe knife behind the insertion of the ciliary border of the iris into the posterior chamber. In other words, it is a posterior paracentesis.

Sclero-choroidal puncture. A posterior scleral paracentesis in detached retina (q. v.).

Sclero-choroidal canal. A name for the optic foramen.

Sclerochoroiditis. Inflammation of the choroid and sclerotic.

Sclerochoroiditis anterior. That form of disease that involves the anterior portions of the sclera and often causes anterior staphyloma.

Sclerochoroiditis posterior. A condition seen in progressive myopia in which posterior staphyloma occurs in the region of the optic disk.

Sclerociliotomy. Hancock's operation for glaucoma (q. v.).

Scleroconjunctival. Pertaining to the sclera and conjunctiva.

Sclerocorneal. Of, or pertaining to, the sclera (sclerotic) and cornea.

Sclerocornea, Dermoid of the. See, also, **Tumors of the eye,** as well as pp. 3523 and 3843, Vol. V of this *Encyclopedia.*

Sclerocorneal junction. CORNEOSCLERAL MARGIN. LIMBUS CORNEÆ. An area of special physiological and pathological interest. This important zone is described on p. 3523, Vol. V of this *Encyclopedia.*

Sclerocorneal trephining. One of the names given the Fergus and the Elliot operation. See **Trephining,** as well as p. 5527, Vol. VII of this *Encyclopedia.*

The Elliot procedure continues to be regarded with much favor. W. H. Wilmer (*Archives of Ophthalm.*, July, 1916) gives his three years experience of this operation, and his present article brings the subject up to date. He claims that though his material is not large, it is valuable, because the cases have been under close supervision at intervals, when the tension, visual acuity, and the visual fields have been recorded. His cases include chronic glaucoma with acute exacerbation, painful glaucoma secondary to irido-cyclitis, glaucoma following cataract extraction, and high tension associated with staphyloma of the cornea. Tension returned twice in 27 cases, both in the eyes of a single patient. In one of these an apparently perfect drainage scar ceased to function 2¾ years after operation and called for a second operation, which was successfully performed. A rupture of the conjunctiva over a trephine opening occurred eight months after operation, and was remedied by a sliding flap.

Wilmer says that the good results in successful cases cannot be attributed to the iridectomy alone, for among them there were five which had undergone iridectomy, and four which had undergone Lagrange's irido-sclerectomy previous to the trephining; the last named operation procured permanent relief of tension, which the others had failed to do, in spite of the free employment of miotics to aid their effect.

Wilmer concludes by claiming that the operation of sclero-corneal trephining presents many advantages. Both eyes can be operated on at the same time, and the patient does not have to be very quiet, or very long confined. The operation can be done with ease, except in

cases where the anterior chamber is abolished. It does not reduce the visual fields, therefore it can be done in those cases where the restriction is almost to the visual centre. It has not immediately reduced vision in any case, but it has improved the sight in a number of cases. It has not caused astigmatism to any accountable extent, and therefore it can safely be done, where the vision is normal, without any undue risk of immediate impairment of sight. There is only a negligible risk of the loss of vitreous, and no danger of the escape of the lens. The operation may be repeated. There is no ideal operative procedure, but in the writer's experience, for permanently reducing excessive tension in all cases of glaucoma, except the acute form, sclerocorneal trephining is the "easiest, safest and most effective method so far presented to ophthalmic surgery."

Sclero-cyclo-iridic puncture. Chibret's operation for glaucoma. See p. 5486, Vol. VII of this *Encyclopedia.*

Sclerocyclotomy. A synonym of Hancock's operation for glaucoma, (q. v.).

Sclerodilitatorectomy. An operation for the relief of glaucoma. See p. 5511, Vol. VII of this *Encyclopedia.*

Sclero-episcleritis, Button-shaped. Under this title Bonino (*Oph. Year-Book,* p. 142, 1913) describes a form of scleritis with keratitis and anterior uveitis in a needlewoman, 60 years of age, where the inflammation, affecting the left eye, had begun a year previously. The symptoms were so severe that enucleation had been recommended. The eye was intensely red, and in the supero-external quadrant of the bulbar conjunctiva there was a large, hard, hyperemic nodule having almost the appearance of an ectasia of the sclera. The episcleral congestion was continuous across the limbus, with an irregular focus of corneal infiltration, which had become ulcerated at one point. The iris was discolored and swollen and the pupil adherent and sluggish in movement. The condition responded, in the course of five months, to repeated multiple, light ignipunctures of the elevated area.

Sclero-iridectomy. See under **Glaucoma,** p. 5510, Vol. VII of this *Encyclopedia.*

Scleroiridotomy. See **Iridosclerotomy.**

Scleroiritis. Inflammation of the sclerotic and iris.

Sclerokeratitis. SCROFULOUS SCLERITIS. DEEP SCLERITIS. SCLEROKERATO-IRITIS. SCLEROSING KERATITIS. Although the first named caption has the synonyms following it, and is not, consequently, a definite pathologic entity, yet the affection generally meant is *Sclerosing keratitis.* See p. 6810, Vol. IX of this *Encyclopedia.* The other captions can be found in their proper places.

Sclerokerato-iritis. Inflammation of sclera, cornea, and iris. See under **Scleritis.**

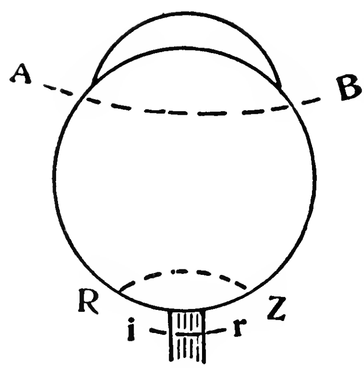
Scleroma. A hardened patch or induration. Lewin and Guillery (*Die Wirkung. von Giften,* Vol. II, p. 600) record a case in which the palpebral conjunctiva was affected.

Sclerometer. An instrument for the determination of degrees of hardness.

Scleronyxis. (1) Surgical puncture of the sclera. (2) The operation done as part of reclination of cataract. See p. 3546, Vol. V of this *Encyclopedia.*

Sclerophthalmia. SCLEROSING KERATITIS. (1.) The condition in which, from imperfect differentiation of the sclera and cornea, the former encroaches on the latter, so that only the central part of the cornea remains clear. (2.) An old term for cancerous disease of the eye; also an obsolete synonym for hordeolum; xerophthalmia.

Sclero-optic. Pertaining to the sclerotic and the optic nerve.



Sclero-optic Neurectomy. (Hall.)

The tissues anterior to the curved line, *A-B*, are to be removed. *R-Z*, Incision in posterior part of the sclera. *i-r*, Part of the optic nerve to be excised.

Sclero-optic neurectomy. This procedure (see p. 4464, Vol. VI of this *Encyclopedia*), a substitute for enucleation, was devised by Ernest Hall of Victoria, B. C. It consists of an evisceration to which is added an excision of the posterior part of the scleral cup and resection of the optic nerve. After cutting away the sclera to an extent sufficient to include the ciliary body and eviscerating the globe, the speculum is inserted within the ball, thus holding both lids and edges of the sclera open. The point of entrance of the optic nerve is then grasped with two forceps and the scissors inserted as close to the nerve as is possible to avoid wounding of the ciliary arteries, and a

circular incision is made in the sclerotic, freeing the optic nerve, which is then drawn forward and severed about ten millimetres from the sclerotic junction, thus removing a section of the optic nerve. The sclerotic and conjunctiva are closed vertically to give normal tension to the internal and external recti, as lateral movement is of greater importance than vertical. After the artificial eye is adapted there is perfect movement within thirty-five degrees laterally and twenty degrees vertically. This operation has been modified by Huizinga, who removes a larger section of the posterior scleral cup, cuts and removes the optic and ciliary nerves, and inserts an artificial vitreous. He has named this operation eviscero-neurotomy.—(J. M. B.)

Sclerosis, Cerebrospinal. See **Sclerosis, Disseminated.**

Sclerosis, Disseminated. INSULAR SCLEROSIS. MULTIPLE SCLEROSIS. CEREBROSPINAL SCLEROSIS. This subject (including the eye symptoms) has been treated under **Disseminated sclerosis**, p. 4041, Vol. VI, of this *Encyclopedia*.

In addition to the matter detailed there E. Velter (*Archives d'Ophtalm.*, p. 585, 1912) reports the case of a patient 28 years old who died of multiple sclerosis. During life, the right eye showed a slight discoloration of the disk, while the left showed an advanced optic atrophy. Summed up, the results of the histologic examination are: (1) The sclerosis of the optic nerve and chiasm is a disseminated neurologic sclerosis, accompanied by an interfascicular connective tissue sclerosis of the optic nerves. (2) The perivascular lesions (sclerosis, thickening and infiltration) appear around the central vessels. (3) There are deep alterations of the myelin sheath, at the level of the sclerotic areas. There is no generalized ascending or descending degeneration. (4) The cylinders are not entirely degenerated; but though they are for the most part conserved at the level of the sclerotic areas, they in places show very important changes. This lesion of the myelin sheath with relative integrity of the axis cylinders is characteristic of multiple sclerosis, and differentiates it from other forms of optic atrophy.

E. A. Shumway (*Ophthalmic Record*, August, 1915) gives the history of a case in which *acute axial optic neuritis appeared as an early symptom in disseminated sclerosis.* He points out that according to Uhthoff, involvement of the visual tracts occurs in nearly one-half of all cases of multiple sclerosis. Atrophy, usually of the temporal half, is the lesion found, and the typical field alteration is a simple scotoma. In characteristic cases the atrophy does not become complete, but leaves a considerable amount of vision. Sometimes the onset is sudden and the condition resembles the acute axial or retro-

bulbar neuritis found in association with sinus complications. The visual disturbance is often the initial symptom of multiple sclerosis and may precede other symptoms of the disease by many years. Often the etiology of a retrobulbar neuritis is very obscure.

Fleischer made a study of the subsequent histories of all cases of acute retrobulbar neuritis, as well as cases of acute papillitis with similar histories. In thirty patients with acute axial neuritis the ocular disturbance was the initial symptom of disseminated sclerosis in sixty-six per cent. of the cases; while in twelve cases of acute papillitis, one-half subsequently developed the disease.

The case reported by Shumway is that of a man, twenty-nine years old, who noticed failing vision in 1907. Vision was 6/22 in the left eye, and there was pallor of the temporal half of the optic nerve and a scotoma for colors. The sinus examination showed a necrosing ethmoiditis. Operation on the nose was performed, and under that and treatment vision improved somewhat, but fell off again to 6/22, where it remained. In 1908 there was some weakness in the right hand and muscles of the leg. In 1914 the diagnosis of insular sclerosis was made.

In the isolated occurrence of cases of acute axial neuritis, a probable diagnosis of multiple sclerosis should only be made if toxic, hereditary, acute or chronic infectious processes can be excluded. It is most important to look for disturbances of the gait, reflexes and sensation.

J. Tarle (*Klin. Monatsbl. f. Augenheilk.*, 54, p. 412, 1916), also discusses this subject of *acute retrobulbar neuritis and multiple sclerosis* after an analysis of twenty-nine recent cases. Only acute cases with the typical clinical picture were considered, excluding the more chronic forms and all those due to affections of the orbit and nasal sinuses and intoxications. Two-thirds of the patients were females. The average age of men was 29, of women 27. As causes were stated: over-exertion, slight febrile diseases, disturbances of the nervous system, loss of blood, and acute infectious diseases. In none was the affection attributed to cold.

The course of the disease in most cases was typical: Vision was suddenly impaired by a more or less dense fog. First, a central scotoma for colors, then a relative and later an absolute central scotoma for white was found, which rapidly spread, leaving remnants of the peripheral visual field or even amaurosis. In twenty-four cases vision was much reduced. The amblyopia lasted from a few days to about four weeks, and disappeared in the way it came. It was noticed, first, that the peripheral portions of the visual field are restored, then the central

scotoma grows smaller, finally more or less marked scotomas, absolute or relative, remain or vision becomes normal. This occurred in eleven cases. Good central vision for white and central disturbances of color perception and paracentral scotomas were observed in six; moderate central impairment of vision with scotomas in seven cases. In five ambulant patients the final result could not be ascertained.

Other ocular symptoms were pain in moving the eyes and on pressure, especially at the beginning; pupillary disorders were frequent, inequality of the pupils occurred in eight.

The affection was bilateral in four cases; in one patient a single eye became affected after the other. No palsies were observed, but there was nystagmus in two cases. The ophthalmoscope revealed different conditions; no changes in the beginning in four; in most cases from the start various degrees of deviation in color and contours; in two marked swelling of the disc and intense venous congestion. At the final observation pathologic conditions invariably were found, i. e., different degrees of post-neuritic atrophy, as well as pallor of the temporal half of the disc, from which the cases with restitution of normal vision were not excluded.

Tarle's investigations confirm the importance of acute retrobulbar neuritis as a valuable early symptom of multiple sclerosis. Not only the observation of the further fate of the patients, affected with retrobulbar neuritis, but the careful examination by neurologists of these cases at the beginning of the ocular affection proved that more than one-third of them, and if those with probable diagnosis are included, more than half, presented simultaneously other neurologic symptoms, which, with the eye disease, established the diagnosis of multiple sclerosis.

Tschirkowsky (*Klin. Mon. f. Aug.*, 53, p. 527, 1915) who records that although ocular disturbances in *disseminated sclerosis* are frequent, *optic neuritis* has been observed only nine times, as reported by the clinical history and post-mortem examination of a peasant, aged 25, who suffered from motor aphasia and paresis of the right arm and both legs. The pupils were equally dilated, did not react to light and on convergence; paresis of left internal rectus, no nystagmus, edematous optic neuritis with relatively slight prominence of discs, and some hemorrhages near the left disc. The patient died two days after admission. The optic nerves in their whole extent and the chiasm presented the changes characteristic of disseminated sclerosis. The blood-vessels were enlarged and their walls infiltrated with hematogenous elements, lymphocytes and plasma-cells. The affection of the nerve fibres was the dominating process in the visual path; dis-

integration of the medullary sheaths, denuded and partially altered axis cylinders, a large number of grill-shaped, respectively granular, cells in the glia of the optic nerve and chiasm. This corresponds with the foci of disseminated sclerosis in other parts of the nervous system, which are characterized by the destruction of the medullary sheaths of the nerve fibres. The prominence of the discs was 2/3 mm.; the tissues were separated by edema, the veins were much dilated and filled with blood.

Sclerosis, Insular. See **Sclerosis, Disseminated.**

Sclerosis, Multiple. See **Sclerosis, Disseminated.**

Sclerosis, Ocular. OCULAR ANGIOSCLEROSIS. SCLEROSIS OF THE OCULAR TISSUES. ARTERIOSCLEROSIS OF THE EYE. By these names is indicated the hardening or over-growth of connective tissue in the oculovascular walls in particular and of the tissues of the eye in general that so often accompany these alterations. This important subject has already been discussed to some extent under **Blood pressure,** p. 1227, Vol. II, **Pressure, Blood,** p. 10366, Vol. XIII, under **Glaucoma,** p. 5432, Vol. VII and elsewhere in this *Encyclopedia.* Here it may be said in addition that *intraocular angiosclerosis* has been thoroughly investigated by de Schweinitz (*Ophthalm. Record*, Aug., 1906) who believes that when this condition can be recognized in the retina it is positive evidence that the sclerosis and arterial tension have reached a dangerous point with regard to eyesight as well as to life. Pathognomonic signs are change in size of retinal arteries causing a beaded appearance; loss of transparency; perivasculitis; and indentation by the stiffened arteries at crossings. The earliest indications are corkscrewing of small arterial twigs arising from large vessels, flattening of a vein where it is in contact with an artery and the congested disc, which is of a dull-red appearance. Persistent asthenopia after presbyopia is well established in women, who frequently present symptoms of neurasthenia, is frequently relieved by reducing high arterial tension. It should be the duty of ophthalmologists to note the warning of retinal changes indicative of arterial sclerosis and high arterial tension, and to see that patients are placed upon a diet and such medication as will tend to relieve this tension. Cases are reported which illustrate the disastrous consequences of failure to do this.

Geo. H. Kress (*Ophthalmoscope,* p. 700, Dec., 1914) points out that the study of sclerosis of the vascular system is especially interesting to ophthalmologists, because in the eye, as nowhere else in the body, do we find an organ with terminal arteries where many of the changes in the structure of the blood-vessels can be thoroughly examined from day to day.

The close association of sclerosis of the vascular system with some of the major faults and vices of our civilization, such as over-eating, high tension living (both mental and physical), alcoholism, and syphilis; and its intimate connection with chronic nephritis (perhaps as often a precursor as a corollary of the last-named disease); as well as with the faults of simple old age and heredity; should make this subject one of much ophthalmologic interest.

Hirschberg, in a series of cases of old persons coming to him for refraction, found evidence of retinal angio-sclerosis in fifty per cent., and microscopic examinations of the retinal vessels of old people show, according to Hertel, an even higher percentage of sclerotic involvement than this.

Increased blood pressure has been noted especially in connection with glaucoma and cataract, and even though it is not possible to stop this lens change, appropriate treatment may, before cataract extraction, somewhat reduce the danger of post-operative hemorrhage.

In angio-sclerosis the inner coat shows a thickening, either from patch-like areas of endothelial proliferation, or from a very considerable addition to the subendothelial connective tissue (the latter more of a fibrosis, and the process most often met with in the veins); the middle coat presenting usually areas of necrosis and hyaline and fatty degeneration, with formation of atheromatous detritus, which may or may not be later on infiltrated with calcareous material. The outer coat in more advanced cases may also show thickening, but whether this is due to the circulating toxins or is only an evidence of compensatory thickening or protection of the vessel wall, is not yet determined.

In phlebo-sclerosis, the intima likewise shows the increase of connective tissue in the internal coat, and the degenerative changes in the outer layers, with a weakening and widening thereof, or if calcareous deposits be associated, then a stiffening or hardening of the vessel.

As a result of the angio-sclerotic changes, the eye tunics are supplied by blood-vessels with narrowed lumina and bathed with blood containing the toxic elements lying at the root of the sclerosis. Consequently, the nutrition and metabolism of the retinal and other ocular tissues suffers. Associated with the above factors are the weakened vessel walls and their greater tendency to leak and be responsible for hemorrhagic spots in the retina.

Sudden diminution of vision of marked amount does not usually result from angio-sclerosis, except when the sclerotic changes occlude the lumen of the central artery or vein; or, with more extensive weakening of the ocular vessels, are responsible for a sudden intra-ocular hemorrhage.

A weakness in the visual power in persons past forty, which does not respond to suitable refractive correction, should, however, lead to a suspicion of vascular changes, and indicate a close examination of the retinal vessels to see if such changes can be discovered.

In patients in whom arterio-sclerosis is suspected, it is well also to have the blood pressure taken, and the heart examined to determine whether an hypertrophied left ventricle is associated with accentuation of the aortic second sound, or increased intensity of the first sound, or whether there is any displacement of the apex beat. A careful and periodical examination of the urine should also be made.

If the picture of retinal angio-sclerosis be at all advanced, even though the general signs of arterio-sclerosis be not prominent, the possibility of concurrent cerebral arterio-sclerosis, with its danger of apoplexy, should be kept in mind.

Just as in tuberculosis we deal with three stages of incipient, intermediate, and terminal involvement, so also in vascular sclerosis do we find a beginning stage, difficult of recognition; an intermediate stage, with franker signs; and a terminal stage, in which the involvement is so general as to nullify much of our attempted therapy. It is in this third or last stage also that patients are seen in whom a steadfast hypotension may succeed a previously persistent hypertension.

The well known changes may, as Kress says, not only involve veins as well as arteries, but also, to a certain extent, be almost limited to the veins—a true *phlebosclerosis.* This seemingly larger involvement of the veins in ocular than in general vascular sclerosis, may be explained in part perhaps, because in the eye we can watch minute changes in the veins, size, course, etc., which because of less firm anatomical structure than the arteries, are less discernible through coarse finger palpation, etc., in other portions of the body.

In the veins, also, there may be the picture of constriction and dilatation in different portions of the same vein.

In the *treatment* of sclerotic changes in the vessels and other tissues of the eye, the very nature of the disease, from the standpoint of causative factors and pathology, necessitates emphasis on the *hygiene of living.* The life which is indicated to be led by such patients should be one of moderation in work, in eating, in exercise, and in personal habits of life; with emphasis on elimination by bowels, kidneys, skin, and respiratory tracts.

Proper drugs have their place, especially the iodides for their alterative and resorptive effects, while symptomatically the nitrites and sedatives, like the bromides, may be of value. The digitalis and strychnin groups can also be called upon if the heart condition indicates their exhibition.

But in any rational therapy, the elimination of the underlying causes of the sclerosis are, of course, of the greatest importance, and in conjunction with the above measures, cannot be too much emphasized.

Sclerosis of the choroid. This subject has been considered under **Atrophy of the choroid** (p. 2131, Vol. III of this *Encyclopedia*). A particular aspect of it—*primary sclerosis*—is, according to C. G. Russ Wood (*Ophthalmoscope*, p. 374, Aug., 1915), an uncommon condition. On the other hand *secondary sclerosis of the choroid* is not infrequently met with in advanced disseminated choroiditis, albuminuric retinitis, and other diseases of the retina and choroid. The sclerotic appearances of the choroidal vessels seen in posterior staphyloma are supposed by some authorities to be due to fissures in the pigment epithelium, consequent on its stretched conditions, because not infrequently the edges of the vessels are serrated.

Regarding primary choroidal sclerosis the writer says it is characterized by atrophy of the hexagonal epithelium and chorio-capillaris, the red fundus becomes browner in tint, due to the exposure of the choroidal stroma with its pigment. The larger choroidal vessels being exposed by the loss of the pigment epithelium and capillaries, stand out clearly, which appearance is accentuated by white lateral streaks on the vessels. There are no signs of inflammation: the condition appears to be a slow degeneration of the vascular tissues.

Roughly, three varieties may be recognized, named according to the areas in which they occur: the "macular," which chiefly, but not entirely, occurs in old people; the "peripapillary," which is most frequently met with; and a "general sclerosis" of the entire visible choroidal vessels.

In the *macular form of choroidal sclerosis* the ophthalmoscopic appearances are limited to the area named, and, in addition there are frequently small hemorrhages which appear to be so thin that the vessels can be dimly seen through them. The disc is pale, as a rule, and may show signs of atrophy; the retinal vessels are in most cases unaffected. The white lateral streaks on the choroidal plexus, in advanced cases, extend across and coalesce, so that the vessels become bands of a creamy-white color. A. S. Morton has figured in the *Transactions of the Ophthalmological Society U. K.*, Vol. V, a very marked case of sclerosis of the whole visible choroid, the vessels of which had become a mere white network, all the red tint having been lost. The *etiology* is obscure. The macular variety occurs chiefly in old people, and may be looked on as a senile degenerative process.

The *peripapillary form* has been said to be due to syphilis, but in

all the cases that Russ Wood has seen it could be excluded. The majority of the writer's cases have been in women, and the disease began in middle life; there were no symptoms of arterio-sclerosis in the vessels of the body generally, and the blood pressure had not been raised.

In the third variety, where there is *general choroidal sclerosis,* Adam says it is either due to syphilis, arterio-sclerosis, or nephritis. In the case reported by Morton, the man was a painter and suffered from gout, so possibly lead may have been a cause.

Leber has shown that the posterior choroidal vessels anastomose very slightly with each other; Coats in his paper on posterior scleritis confirms these observations; but even if there is no anastomosis, the current must be very sluggish in these vessels, so that it is probable whatever toxic agent causes the disease, plenty of opportunity is given for its action. That toxic substances circulating in the blood have a selective activity is well known, and in the eye is shown by the way in which albuminuria chiefly affects the retinal arteries and syphilis the choroidal vessels.

Hepburn showed that the posterior ciliary arteries nourish three separate areas, which are supplied by three groups of vessels, the macula, the mid-periphery, and the extreme periphery; this observation is of interest because it corresponds to the first two areas wherein primary choroidal sclerosis is found.

The pathological anatomy is that of endarteritis, the vessels in extreme cases becoming mere fibrous cords.

The *prognosis* as regards vision is grave, especially in general sclerosis of the choroid. In the macular variety, although central vision is lost, total blindness does not result. In the perimacular cases also, total blindness does not take place. An important practical point in this connection is that choroidal sclerosis is not associated with cerebral sclerosis. On the contrary, when this disease attacks the retinal vessels, as well known, the cerebral vessels are usually concurrently affected. Hemorrhages certainly increase the gravity of the prognosis as regards vision.

Sclerosis of the cornea. One of the forms of this alteration is a sclerosing keratitis; see p. 6811, Vol. IX of this *Encyclopedia.*

Fuchs has described a rare condition—*sclerosis and atrophy of the cornea*—in which a groove-like depression circumscribes the periphery of the cornea without the occurrence of ulceration. The disease, which is found chiefly in elderly persons, is a senile change ingrafted upon a concomitant arcus senilis. There is a hyalin deposit in the superficial corneal layers. Some of the hyalin masses may be visible in the

living eye, examined under a loupe, appearing as whitish points. Ectasia of the cornea has been present in some of these cases. There is no known treatment for the condition.—(J. M. B.)

Sclerosis of the optic nerve. This condition is almost altogether confined to the optic changes associated with lateral and disseminated sclerosis (q. v.).

Sclerosis of the retina. See **Retina, Sclerosis of the.**

Sclerosis, Posterio-lateral. For the eye signs see **Neurology of the eye,** p. 8355, Vol. XI of this *Encyclopedia.*

Sclerosis, Posterior, of the cord. See **Tabes dorsalis**; also p. 8356, Vol. XI of this *Encyclopedia.*

Sclerosis, Primary lateral. For the ocular signs, see **Neurology of the eye,** p. 8355, Vol. XI of this *Encyclopedia.*

Sclerostomy. SCLEROTOMY. Incision of the sclera—generally for glaucoma. The former term is by some used improperly as a synonym of Holth's operation. See p. 5524, Vol. VIII of this *Encyclopedia.*

T. Harrison Butler (*Ophthalmoscope*, August, 1915) gives an account of eight cases of late infection following sclerostomy by the Holth punch operation. The cases are divided into three groups: (1) acute cases, ending in acute uveitis and panophthalmitis, necessitating removal of the eye; (2) cases of severe iridocyclitis, which destroy the sight; (3) cases of mild iritis and local inflammation around the aperture, which recover.

Three of the eight cases were included in the first group, one in the second and three in the third. Brief descriptions of the cases are given. Every kind of scar was affected. In one case there was apparently firm cicatrization with no filtration; others had ectatic scars. In two a small buttonhole was made at the operation, which is considered an added danger. A thick flap of conjunctiva was always attempted, a thin covering to the aperture being obviously unsafe.

While the writer's cases were mostly completed with the punch, and therefore his conclusion can not be applied to the trephine operation, he concludes that late infection is a peril hanging over every eye which possesses a filtering cicatrix of any type, however obtained.

G. H. Pooley (*Ophthalm. Review*, p. 202, July, 1913) has performed with success a form of sclerostomy by the aid of a modified Lang's anterior synechia knife with a stiff rigid blade 11 to 12 mm. long and very narrow, on a rigid shank.

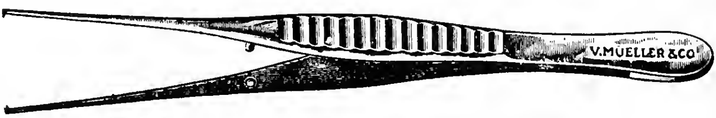
He says the incision must be small so that the lens cannot escape or present in the wound and damage its capsule. Since astigmatism is due to over-riding of the margins of the wound, if the incision is small, does not gape and its edges are squarely cut, one is not likely

to get much astigmatism. The orifice should connect the anterior chamber with the subconjunctival areolar tissue and be placed as far forward as possible so as to avoid blocking by the base of the iris or the ciliary body, and the necessity for a large iridectomy, while obtaining the protection of a conjunctival flap against infection of the interior of the eyeball through the operative fissure.

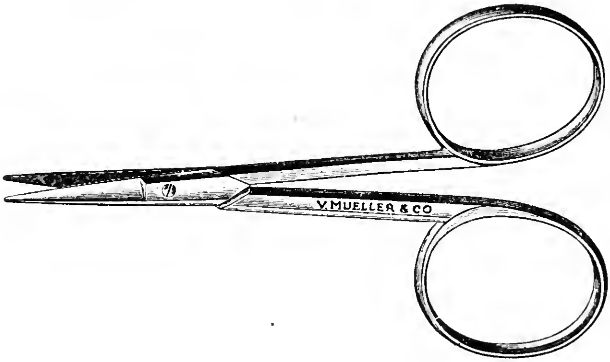
By making the puncture and counter puncture about 1 mm. out-

Lang's Anterior Synechia Knife, as Modified by Pooley.

side the attachment of the conjunctiva to the cornea and by cutting squarely outwards as near to the corneal attachment of the conjunctiva as possible, a section of the cornea with a conjunctival flap can be obtained and owing to the leaking of the aqueous into the subconjunctival tissues often with only a linear wound of the conjunctiva. The tissue should be removed as far as possible in the vertical rather than in the horizontal meridian; this can be accomplished by seizing



Pooley's Forceps for Sclerostomy Operation.



Scissors for Pooley's Sclerostomy Operation.

the posterior lip of the wound with a pair of forceps, and excising a piece about $1\frac{1}{2}$ mm. in diameter and roughly square in shape. The forceps are straight and are like miniature fixation forceps, with two small teeth, one on the blade that is introduced into the eyeball, and one long tooth on the blade that is outside the eyeball. The scissors are short tenotomy scissors.

Pooley claims for his sclerostomy the following advantages: (1) As to vision. This is usually most satisfactory, there is generally a steady improvement for a long time afterwards. (2) As to the visual field. This is usually no less, in some cases it is apparently larger. (3) As to astigmatism. Usually from 0.5 to 1 dioptre, sometimes less than 0.5. (4) As to glare. Annoyance from this is usually absent. (5) As to tension. This usually remains normal or less than + 1. (6) As to filtration. This is usually free, and remains so, the conjunctiva pitting on pressure, even in one case where the stroma was partly blocked by uveal tissue, there was still pitting more than two years after the operation. (7) Iritic adhesions are usually absent.

Sclerotic. See **Sclera.**

Sclerotica. The sclerotic coat; the sclera.

Scleroticectomy. Excision of a portion of the sclera.

Scleroticitis. SCLEROTITIS. SCLERITIS. SCLIRITIS. Inflammation of the sclerotic coat of the eyeball.

Scleroticochoroiditis. See **Sclerochoroiditis.**

Sclerotico-choroiditis posterior. A term applied by von Graefe to myopic conus. See **Conus,** as well as *Myopia,* under **Refraction and accommodation of the eye.**

Scleroticonyxis. COUCHING OF CATARACT. An old operation, consisting in puncturing the sclerotic behind the ciliary region with a broad needle, passing the needle between the iris and the lens, and depressing the lens into the vitreous. Same as scleronyxis.

Scleroticopuncture. Scleronyxis.

Scleroticotomia. The operation of cutting through the sclerotic coat.

Scleroticotomy. Surgical incision of the sclera.

Sclerotics, Blue. See p. 1237, Vol. II, p. 5827, Vol. VIII, as well as p. 5146, Vol. VII of this *Encyclopedia.*

In addition to the material there presented the essay of Sydney Stephenson (*Ophthalmoscope*, p. 278, 1915), who discusses the bibliography of this interesting subject, is here quoted freely, with the appended bibliography.

The writer refers to the original observation of von Ammon and to succeeding writers on various aspects of the syndrome. In the year 1841 the former spoke of a peculiar bluish-white coloration of the sclera that may be encountered in cases where the whole development of the eye is backward. A passing reference to a similar condition was made in 1848 by C. A. E. Cornaz, and in 1862 by Sir W. R. Wilde.

Upwards of forty years later Leslie Buchanan, of Glasgow, described an unusually thin corneo-sclera that he had found on pathological

examination of the eye of a girl of nine years, which had been removed on account of an injury. The cornea was three-fifths and the sclera one-third of the normal thickness, and the fibres, although of natural size, were unusually few in number. Bowman's membrane was absent. In 1907 Percival J. Hay, of Sheffield, under the name of "pseudo-coloboma," described a congenital anomaly of the sclera in a still-born hydrocephalic child, who presented many other deformities. One eye showed a triangular area, as dark as the pupil, in the sclera on both inner and outer side of the cornea, and the other eye a similar condition, but on the outer side of the cornea alone. Histological examination showed the unusual appearance as due to local thinning of the sclera, thereby allowing the dark color of the uvea to be perceived through the attenuated parts.

Stephenson further observes that in a modest communication published in 1900 Arthur Eddowes first drew attention to the connection between "blue sclerotics and brittle bones." He had seen a little lad with very dark sclerotics, who, during the two years he remained under observation, had been affected with no fewer than nine independent fractures, not to mention a slight greenstick fracture of the tibia, which the child's mother treated herself by binding the limb at the seat of the fracture with a necktie. A history of a similar kind was obtained by Eddowes from a girl who possessed remarkably dark sclerotics. She had broken a bone on one occasion by merely falling on the bed. The patient stated that her father's eyes were like hers, and that he also had broken his bones several times, only recently sustaining a fracture of the arm whilst putting his coat on.

Eddowes, then, was the first not only to point to the connection between "blue sclerotics" and fragility of the bones, but also to the hereditary nature of the scleral condition.

The tendency to spontaneous fracture has been widely confirmed since it was mentioned by Eddowes. The assigned cause is often ludicrously insufficient to fracture anything like a healthy bone. One of Burrows' patients broke the femur by sitting down suddenly on the nursery floor, and another fractured the tibia by missing the last step on the stairs. In a girl, aged twelve years, whose case is reported by Conlon, the left hip was broken and dislocated by a fall from a height of ten or twelve inches, and on another occasion her right leg was broken by a fall caused by a dog jumping on her. In Boynton's case the left tibia and fibula were broken by a blow from a child's fist. In the family described by Peters the father had broken his right leg on two occasions, first, when ten years of age, by falling over a stick, and later by a simple fall, while later still he fractured his left

forearm by his head striking his arm as he slipped upon a smooth surface. His second son, when four years of age, broke his left leg by falling from a bench which stood in the porch of the house. Eight years afterwards the same lad broke his forearm by being tripped up and falling flat upon his stomach. At the moment when Peters wrote, another son was in hospital from a leg fractured from some unknown cause. Speaking of a girl included in the pedigree published in 1910, the mother said "she had got quite used to picking her up broken" after a slight fall.

In Eddowes' case there were ten fractures during a period of two years. In a case reported by M. Ostheimer there had been nine fractures between the age of one-and-a-half and four years, the child breaking the left femur five times, the right four times, and the left humerus once.

The fragility of the bones applies only to such members of the families as have actually inherited the "blue sclerotics," a point upon which H. Burrows has dwelt.

F. A. Conlon has found by means of X-ray that the long bones in his patients had a much enlarged medullary canal and a very clearly defined cortex. All the bones, indeed, showed lack of density and marked atrophy.

In 1908, A. Peters, of Rostock, reported instances of "blue sclerotics" in four generations of one family. The appearance of the eyes was attributed by him to congenital thinning of the sclera. In 1910 Stephenson described the condition in 21 out of 32 members belonging to four generations of one family; and, shortly after, N. Bishop Harman added another generation to the same family, so that a total of over 55 individuals was recorded, of which 31 were the subject of "blue sclerotics." In this extensive pedigree females were mainly affected—82 per cent. as against 44 per cent. of the males.

Other cases illustrating the hereditary nature of "blue sclerotics" were published in 1911 by J. D. Rolleston and H. Burrows, in 1912 by C. A. Adair-Dighton, in 1913 by F. A. Conlon, and in 1914 by E. A. Cockayne and M. Ostheimer respectively. Transmission of the scleral peculiarity, as shown by examination of the pedigrees, seems to occur only through the affected members, generally females. Transmission to males through unaffected females does not take place. Briefly, "blue sclerotics" are the result of what Bateson has called "the knight's move" in heredity (Conlon).

Behr, who reported a case of conical cornea in association with "blue sclerotics," drew attention to the dislocations to which the patient was habitually subject. E. A. Cockayne noted the liability to sprains,

and in explanation thereof suggested that all the fibrous structures around the joints were unduly weak and thin in these cases. He also commented upon the small physique of the patients, a point previously mentioned by Harman.

The congenital opacity of the cornea known as embryontoxon has been observed in cases of "blue sclerotics" by Peters, Harman, Conlon, and Stephenson. In some of the Stephenson's cases, as in Harman's, Fuchs' coloboma has been present.

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Frank A. Conlon (*Am. Journ. of Ophthalm.*, Oct., 1918) writes a supplementary note to his first report, on the association of *otosclerosis with blue sclera*. He says: "After reading Bronson's article on 'Fragilitas ossium and its association with blue sclerotics and otosclerosis,' I took the first opportunity presenting itself to examine my family for the possible associated ear condition. I was very much chagrined to find that I had overlooked this part of the symptom complex which we now know includes blue scleræ, a marked tendency to spontaneous dislocation, sprain, and fracture; small stature; and *otosclerosis.*

The father of this present generation previously reported by me has otosclerosis, and all of his family who had blue sclerotics were also deaf, and those who had normal colored scleræ had normal hearing, the deafness in all cases coming on after thirty.

The age that the deafness developed in these cases is suggestive, if not conclusive, that these were also cases of otosclerosis.

None of the five girls in my family shows any evidence of otosclerosis, but considering that not one is over thirty this is not so remarkable.

Since publishing my article in 1913 two children have been born, one with and one without the blue colored sclera. One month ago a member of the family received a badly fractured knee from rather a slight trauma.

Bronson reports out of a family of four generations, thirty-four of whom he examined, twenty-one had gray-blue sclerotics—twenty suffered from fractures and seven members had progressive deafness which was found to be otosclerosis.

Van der Hoeve and de Kleijn were the first to notice otosclerosis in connection with this very interesting anomaly. Out of eleven without blue sclerotics, all were deaf and ten had broken one or more bones. In their second family three members were deaf from otosclerosis.

Van der Hoeve says: 'The blue sclera is observed when the anomaly is there; the fragility of the bones, on the contrary, can be present unobserved because an accident is necessary to put it in evidence, and deafness is progressive, so that it is not perceived before a certain age—so although all the symptoms of the syndrome may be present only the blue scleras are noticed.' "

Sclerotitis. Inflammation of the sclerotic; scleritis (q. v.).

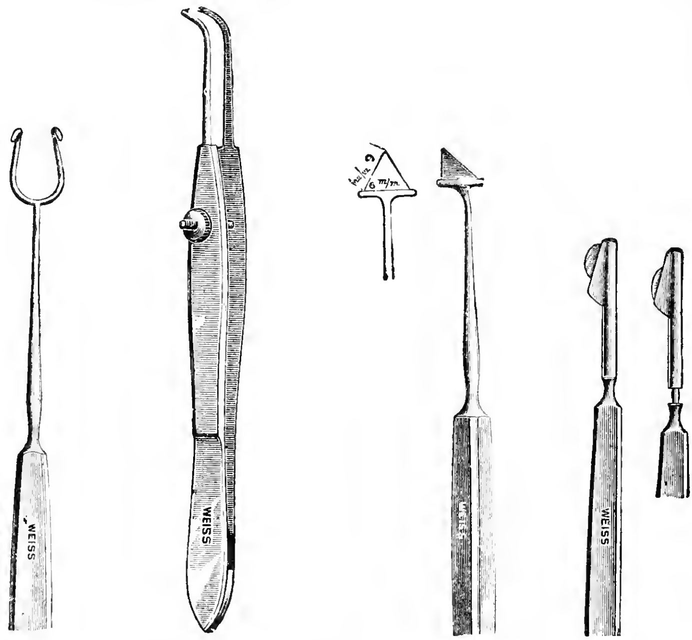
Sclerotome. An instrument for making an incision or operative wound in the sclera, usually for the relief of glaucoma (q. v.).

Holth's latest forms of instruments (including the sclerotome) are pictured in the text. See p. 5983, Vol. VIII of this *Encyclopedia*.

In the same way a cut of Michaud's sclerotome is also shown.

Sclerotomia antero-posterior. See p. 5487, Vol. VII of this *Encyclopedia.*

Sclerotomia cruciata multiplex. GRILL-LIKE SCLEROTOMY. See p. 5552, Vol. VII of this *Encyclopedia.*



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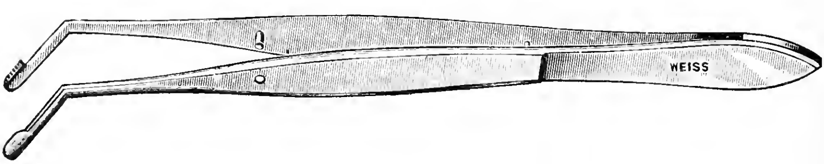


121

Sclerectomy Instruments of S. Holth.

117. Double conjunctival hook. 118. Iris forceps, with regulating screw. 119. Keratome, with stop. 120. Sclerotome, guarded, to regulate depth of incision. 121. Fixation forceps, elbowed.

Sclerotomy. SCLEROSTOMY. Surgical incision of the sclera, generally for glaucoma (q. v.) and detached retina (q. v.).

Michaud's Sclerotome.

Sclerotomy, Anterior. See p. 508, Vol. I of this *Encyclopedia.*

Sclerotomy, Combined. This operation was devised (for the relief of glaucoma) in 1894 by de Wecker (*Annales d' Ocul.*, p. 261, 1894.)

It had for its object the production of artificial dialysis. After the pupil had been contracted with eserin and the eye cocainized, de Wecker introduced the 6 mm. broad stop knife which he especially designed for the purpose, 1 mm. behind the upper limbus and the incision was made as for ordinary iridectomy. After the aqueous had flowed off slowly to prevent iris prolapse, a very delicate iris forceps with prongs well rounded off at the extremity were introduced into the anterior chamber and a fold of iris seized 2 mm. from the limbus. The iris was then gently drawn toward the centre of the cornea and traction made until its periphery was detached from its root to the extent of 6 or 8 mm. A profuse hemorrhage usually follows, filling the anterior chamber. The forceps are then opened to prevent the iris being drawn back again to the periphery and held for a few minutes in the incision to facilitate the escape of blood and prevent the severed iris from prolapsing.—(W. C. P.)

Sclerotomy, Grill-like. See **Sclerotomia cruciata.**

Sclerotomy, Posterior. See p. 5549, Vol. VII of this *Encyclopedia.*

Sclerotomy, Small equatorial. See **Glaucoma.**

Sclerotomy, Small-flap. Herbert's operation. In the *Oph. Rev.*, June, 1911, Herbert gave an interim report of the *small flap sclerotomy* for glaucoma. He had performed 54 operations, 41 by cutting the scleral flap with the narrow knife, and 13 with Bishop Harman's twin scissors. See p. 5811, Vol. VIII of this *Encyclopedia;* as well as the rubric **Scissors.**

Of the 54 operations only 3 had failed: one from acute glaucoma in a blind eye due to prolapse of the iris and adhesion, two in secondary glaucoma from cyclitis; these failures were in blind or partially blind eyes. In two other blind painful eyes success was partial; tension was only moderately relieved, but pain was stopped.

A priori the scissor cuts should be more effective, but he thought the reflection of the conjunctiva tended to tie down the free end of the flap so that conjunctival edema appeared to be less.

Sclerotomy, T-shaped. See **T-shaped sclerotomy.**

Sclerotonyxis. See **Scleroticonyxis.**

Scolex. A cestode parasite—tapeworm, for example—in the larval stage, when it consists of a head and vesicular body, without organs.

Each ovum of the *ecchinococcus hominis* contains an embryo (*proscolex*). On entering the stomach of the host the embryo is liberated from the ovum by the action of the gastric juice, and bores its way through the stomachic or intestinal walls, and, by the blood-vessels or lymph-channels, finds its way into some solid organ, where it develops into a cyst *(scolex).*

Scoliosis, Ocular. Spinal curvature attributed to tilting of the head on account of astigmatism. See **Tilting, Head.**

Scoop, Mules'. A form of curet used in eye operations.

Scopola. The dried rhizome and larger roots of *Scopolia carniolica.* It contains the same constituents as *Atropa belladonna,* and is used like belladonna.

Scopolamin. HYOSCIN. This agent obtains its first name from *Scopolia carniolica,* or Japanese belladonna, from which, with some atropin and hyoscyamin, it may be obtained. It commonly occurs as the hydrochloride ($C_{17}H_{23}NO_3HCl_3$) and hydrobromide, in rhomboid, transparent crystals very soluble in water, less soluble in alcohol. It is chemically, physiologically and clinically identical with hyoscin, and is given a heading here to emphasize that fact. See **Hyoscin,** p. 6090, Vol. VIII; also **Cycloplegics,** p. 3641, Vol. V of this *Encyclopedia.* To this matter is here appended the observations of F. W. Marlow (*Ophthalmic Review,* March, 1911) who used scopolamin hydrobromid in place of homatropin as a cycloplegic for ten years and is very well satisfied with the results. He regards the inconvenience of the frequent instillations necessary in the case of the latter drug, the irritation produced by it and its not infrequent failure to produce a complete relaxation of the ciliary muscles, as reasons for a change to a drug of presumably greater efficiency, which requires only one instillation for the production of cycloplegia in a shorter space of time. The great disadvantage of scopolamin as compared with homatropin, viz., that its effects take about three times as long to pass off, has not proved to be a serious one in practice, although he uses a cycloplegic in practically all cases requiring the prescription of glasses up to 40 years of age, and in a certain number of cases even beyond that age. It has generally been found practicable, even in those cases in which an interference with work seemed impossible, to institute some arrangement which would make the method feasible.

He employs a one-fifth of 1 per cent. solution and uses one instillation; examination is made at the end of an hour or a slightly longer interval; if necessary a solution of eserin, one-tenth of a grain to the dram, is used after the examination, to neutralize the effects of the mydriatic.

In the great majority of cases the cycloplegia seems to have been complete, and one instillation is as effective as two; even in the cases in which a second application effected a more complete cycloplegia the change was very slight and was usually a negligible quantity.

[When for any reason homatropin and cocain discs are believed to be insufficient—even when employed after the manner described by

myself many years ago—their cycloplegic strength can be much increased by the additional employment of a single disc containing 1/2000 of a grain of hyoscin (perhaps a better name than scopolamin). The cycloplegia and mydriasis pass off in about three days, while the maximum result is obtained in about two hours after using the discs. —Ed.]

Kümmell (*Oph. Year-Book*, p. 42, 1913) notes that narcosis by scopolamin injections, with or without the opium derivatives—may be used to shorten the administration of ether or chloroform. He finds that in elderly people, and also in the weak or decrepit, quiet sleep is produced by a single dose of 0.5 mg. In strong, healthy men a second, somewhat smaller, dose may be required. In women the dose is one-quarter to one-third less. See under **Anesthesia in ophthalmic surgery**, p. 435, Vol. I of this *Encyclopedia*.

From tests and control tests on about forty persons, Beck concludes that no difference exists between the action of fresh solutions of scopolamin and solutions which have been kept for as long as six months.

Scopolamin, Iota. See **Atroscina**, p. 676, Vol. I of this *Encyclopedia*.

Scopolamin-morphia anesthesia. See p. 435, Vol. I of this *Encyclopedia*.

Scopolein. A crystalline, poisonous alkaloid, $C_{17}H_{21}NO_4$, from plants of the genera *Scopolia*, *Duboisia*, and *Atropa;* it is a strong mydriatic, cycloplegic and sedative, closely related scopolamin and atropin.

Scopolia. A genus of solanaceous plants. *Scopolia atropoides (carniolica)*, of Europe, and *Scopolia japonica* and *Scopolia lurida*, of Asia, have properties like those of hyoscyamus and belladonna.

Scopolia atropoides. SCOPOLIA CARNIOLICA. NIGHTSHADE-LEAVED HENBANE. A plant growing in Carniola, Croatia, and Hungary, having the poisonous, narcotic and cycloplegic properties of *Hyoscyamus niger*.

Scopolia japonica. A Japanese plant regarded as the source of Japanese belladonna.

Scopolia lurida. A plant found in Nepal and the Himalayas. The leaves emit, when bruised, a peculiar tobacco-like odor and are powerfully mydriatic and cycloplegic.

Scopolin. An alkaloid or glucosid, $C_8H_{13}NO_2$, obtainable from scopolamin; a narcotic.

Scopomorphin. The trade (Riedel, Berlin) name of a mixture containing scopolamin hydrobromide, gr. 1/50, morphia hydrochloride, gr. 1/2, distilled water, thirty minims, to be used for injection in general anesthesia. Ten minims are to be injected 3 hours before the proposed eye operation and another ten minims an hour and a half later. It is rarely necessary to use the remaining ten minims. Cocain may

be combined with this preparation to lessen still further the local irritation.

Scotasma. (L.) An obsolete term for both amblyopia and scotoma.

Scotasmus. (L.) Caligo.

Scotinophora. Takashima describes the ocular conditions produced by the insect *scotinophora,* found in rice fields. It produces an edema of the lids and conjunctiva, accompanied later by a mucopurulent discharge, probably induced by contact with the insect or its body juices.

Scotodia. (L.) (Obs.) Amblyopia.

Scotodinia. (L.) Headache with vertigo and impairment of vision.

Scotogram. SCOTOGRAPH. Same as *skiagraph;* also, the effect produced upon a photographic plate in the dark by certain substances.

Scotographoscope. An instrument for showing diagrams in a dark room.

Scotography. Same as skiagraphy.

Scotoma. SCOTOME. A patch or area in the visual field corresponding to some abnormality in the retina or other part of the visual conducting apparatus. In this connection the section on **Examination of the eye** and on **Perimetry,** and especially p. 9470, Vol. XII of this *Encyclopedia* should be consulted. In addition to the material there provided reference is (again) made, under the following captions, to the various forms of *scotomata.*

Scotoma, Absolute. A defect in the visual field for both form and color.

Scotoma, Annular. RING SCOTOMA. A variety that encircles but does not involve the fixation point.

Scotoma, Central. A defect in the field that is confined or mostly affects the point of fixation.

Scotoma, Color. A variety that involves the color field, leaving the form field intact. See, e. g., p. 2418, Vol. IV of this *Encyclopedia.*

Scotoma, False. As opposed to true scotoma (due to some lesion of the central nervous system or optic conducting apparatus) false scotomata arise from disease in the ocular media (hyalitis, cataract, hemorrhage, etc.) that acts as an obstruction to vision.

Scotoma, Flittering. TEICHOPSIA. A variety of scotoma with serrate margins (often seen in *migraine*) usually producing an extensive defect of vision.

Scotoma, Fortification. One of the symptoms of migraine (q. v.).

Scotomagraph. An instrument for recording a scotoma; a perimeter.

Scotomagraph with stereoscopic fixation. This instrument, though primarily designed for mapping out blind or anesthetic areas, can be used for general perimetry. The test object is a second image of the

fixation point, obtained by reflection from a long narrow mirror hinged near the eye-piece of the instrument. The angular position of the second image, as seen by the retina, is determined by the position of the mirror which can be rocked about its hinge through a device inside the instrument. The whole apparatus can be rotated about its axis so that while the fixation point remains unmoved the second image makes a circular excursion, thus enabling the method of Bjerrum to be employed in testing for glaucoma. An automatic registration is obtained by means of a needle which is carried by the mirror and extended pneumatically by a mechanism similar to that used for operating a photographic shutter. The second eye looks down a tube at a small spot the same size as that already viewed by the eye under examination; the brain interprets this as the same spot and stereoscopic fixation is thus obtained.

Scotoma heliecliptieum. As stated by C. Hirsch (*Wien. Klin. Rundschau*, July 21, 1912), and as is generally known, in snow blindness and electric ophthalmia, the outer anterior parts of the eye become affected, whereas during observations of the sun's eclipse the lesion is located in the macula lutea. The chief symptom in the latter instance, therefore, is a "scotoma heliecliptieum." The scotoma, as a rule, is a positive one. The power of vision is usually diminished, but the field of vision and the sense of color are normal. Ophthalmoscopic examination often shows a normal condition in spite of the presence of a functional disorder.

In the majority of cases, there is a positive but no absolute scotoma. See, also, **Eclipse amblyopia.**

Scotoma, Hemianopic ring. This term was coined by Rübel (*Oph. Year-Book*, p. 297, 1914) for an unusual case of apoplectic involvement of the visual fields, occurring in a man of 38 years. The central macular region was retained bilaterally for an extent of three degrees in the horizontal and four degrees in the vertical. At the time of examination each field showed a large absolute scotoma for white and colors, interrupted by two semilunar strips in which white was recognized as gray. The vision had first become affected in 1900, when after an attack of articular rheumatism the patient suffered from violent headaches and transitory disturbance of consciousness. From this time the right halves of the visual fields were defective. The symptoms of a further attack in 1912 included headaches and disturbances of consciousness and loss of speech. Two or three months later there was a further attack in which vision was said to have been completely lost, and this attack was followed by loss of orientation

which lasted for a week. The only symptom which was prominent was the disturbance of vision. With Hess' hemikinesometer there was a weak but distinct pupillary reaction. Hysteria was excluded. Although the case was under observation for seventeen months no change was discovered in the fundus. Rübel assumes lesions situated in the cortex or its immediate vicinity, and occurring at an interval of twelve years first on the left side of the brain and afterwards on the right side. The vascular changes were sufficiently explained by the existence of a chronic nephritis.

Scotoma, Indistinct. One in which there is diminished perception but not actual loss of colors, white and form.

Scotoma, Motile. The shadows cast upon the fundus by opacities of the vitreous are sometimes so designated.

Scotoma, Negative. An area of the field of vision within which the image of an object is not, as a rule, perceived. The patient is not conscious of this defect, which must be mapped out with the perimeter.

Scotoma, Paracentral. Paramacular scotoma. A defect in the visual field that involves an area in the immediate neighborhood of the fixation point.

Scotoma, Paramacular. Paracentral scotoma. A defect in visual field affecting the immediate neighborhood of the fixation. Frenkel (*Archives d'Ophtalm.*, July, 1916; abstract in the *British Journ. of Ophthalm.*, p. 113, Feb., 1917) reports an example in a soldier, 22 years of age, who was wounded in the occipital region by a fragment of shell. He was unconscious for six hours, and when he came to himself, was found to be blind. The blindness, after persisting for seven or eight days, then improved somewhat. The man was trephined a couple of months after the injury, and the operation was followed by improvement in the general health but not in the sight.

When he was examined by Frenkel some sixteen months after the original injury, the pupil of the right eye was a little (1 mm.) larger than that of the left. The pupillary reactions were normal, and could be elicited no matter on what part of the retina the light was thrown. The optic discs showed no departure from normal. V.=0.1 and No. 7 Wecker. In order to obtain this sight, the patient inclined the head towards the left in reading with the right eye, and *vice versa*. There was slight concentric contraction of the field as regards blue, red, and green. There was a scotoma of hemianopic type lying immediately below each fixation point, larger in the case of the left than of the right field.

Scotoma, Peripapillary. A variety resulting from a lesion affecting

the neighborhood of the optic disk; enlargement of the blind spot.

Scotoma, Peripheral. A defect in the field removed from the fixation point.

Scotoma, Physiologic. The defect in the field of vision corresponding to the blind spot of Mariotte. See p. 1205, Vol. II of this *Encyclopedia*.

Scotoma, Positive. A defect in the field that shows itself as a cloud definitely noticed by the patient. It is generally due to disease of the retina.

Scotoma, Relative. A scotoma in which there is no perception of one or more colors—in some cases all of them—but in which form perception remains normal.

Scotoma, Ring. RING-SHAPED SCOTOMA. See **Scotoma, Annular.** Weeks (*Diseases of the Eye*, p. 144) points out that disease of the intermediate zone of the visual field, lying between the fifteenth and forty-fifth degrees on the perimeter, and corresponding to the choroidal zone supplied by the short ciliary arteries, is the common cause of this defect.

A. von Szily (*Ophthalmology*, p. 618, July, 1913) reports the case of a student, aged 25, who was kicked on his head by a horse. In December, 1911, he came complaining of haziness before his eyes and diplopia. Examination revealed bilateral choked disc without hemorrhages and paralysis of the left abducens. The patellar reflexes were abolished; there were slight tremors of hands and legs and slight disturbances of equilibrium. Wassermann was negative. A cerebellar tumor was diagnosed, and as vision commenced to fail, puncture of the corpus callosum was done and 150 ccm. fluid emptied, with improvement of the subjective symptoms and a slight receding of the choked discs. While the blind spot in the left eye remained stationary, a *ring-shaped scotoma developed in the right eye.*

A good account of ring scotoma is given by Hancock (*Roy. Lond. Oph. Hosp. Reports*, Vol. XVI, p. 496).

Scotoma, Spectrum. AMAUROSIS PARTIALIS FUGAX. SCINTILLATING SCOTOMA. A defect in the field generally accompanying migraine. See p. 5276, Vol. VII of this *Encyclopedia*, also **Spectrum scotoma.**

Scotoma scintillans. SPECTRAL SCOTOMA. One of the numerous terms applied to the visual defects in the field characteristic of marked migraine. See p. 7694, Vol. X of this *Encyclopedia*, also heading above.

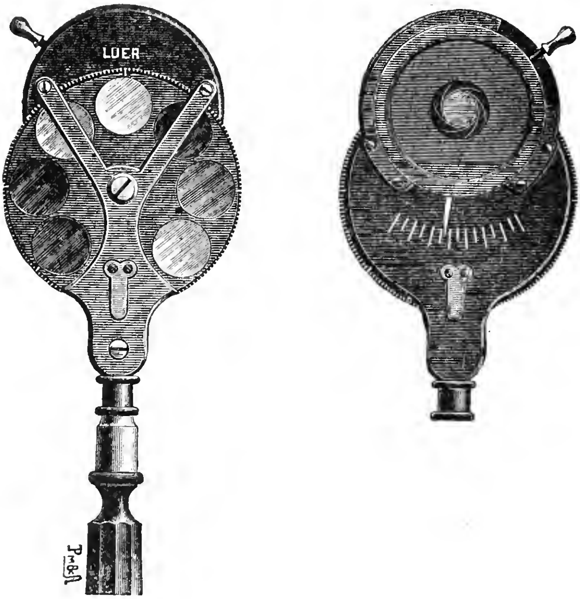
Scotoma, True. That due to a lesion of the brain, cord or conducting apparatus of the visual apparatus, as opposed to the shadows cast by opacities of the ocular media that constitute *false* scotomata.

Scotoma, Unilateral. That defect occurring in only one eye.

Scotoma, Van der Hoeve's. Enlargement of the blind spot for both form and colors. See p. 5969, Vol. VIII of this *Encyclopedia.*

Scotometer. An instrument for diagnosticating and measuring scotomata. A number of these have already been described under **Examination of the eye,** as well as under the headings **Perimeter** and **Perimetry.** A few others are described here.

Antonelli's scotometer. This so-called "iris-diaphragm" scotometer is provided with white and colored paper and glass discs arranged like the small lenses of the ordinary ophthalmoscope. See the figures.



Antonelli's Scotometer.

Bardsley's scotometer (a miniature Bjerrum screen), is partially described and depicted on p. 4782, Vol. VI and p. 9477, Vol. XII of this *Encyclopedia.* Here it may be said that this useful instrument is now made in a slightly modified form. The hollow spherical metal disc instead of being blacked is lined with a smooth black cloth, thus avoiding the bright patches tending to distract the patient's attention. A further advantage is that the slit along which the pointer moves is practically closed by the overlapping of the cloth edges so that any light which may be behind is not so readily noticed by the patient. The actual construction of this shell has also been improved to make it rotate with freedom from unsteadiness. A new chart has also been

designed and is shown in the illustration. Instead of the radial lines being solid as hitherto, they are in the form of dashes, each dash representing one degree, thus enabling the points to be marked with greater facility. By having the blind spot dotted on both sides of the centre the necessity for using two sets of charts, one for the right eye and one for the left, is avoided.

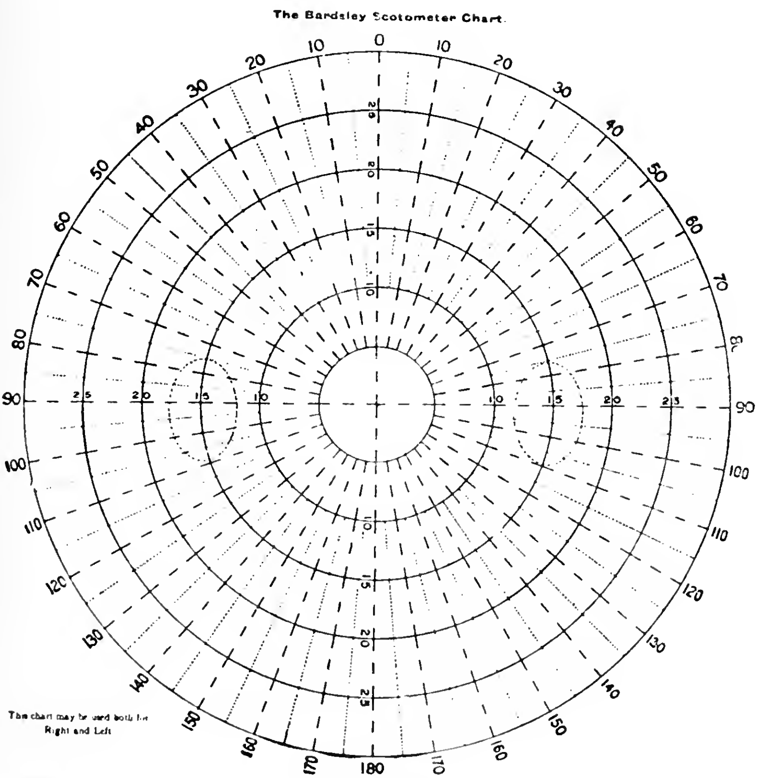


Chart for the Bardsley Scotometer.

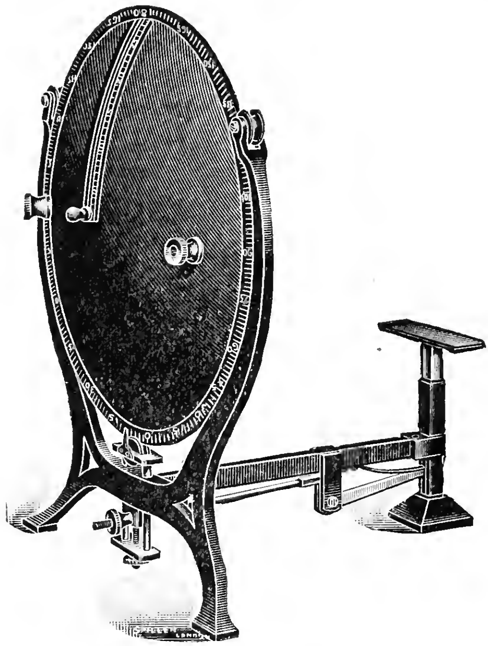
Birch-Hirschfeld's scotometer. This is an instrument for the detection and measurement of central scotomata. Two rotating metal disks hold the white and colored objects—of various diameters. By combinations of these 54 shades and sizes can be arranged.

Cruise's scotometer. See p. 3574, Vol. V of this *Encyclopedia.*

Bishop Harman's pocket scotometer is pictured in this text.

Thomson Henderson's scotometer is described in the *Ophthalmoscope,* May, 1914. Instead of reflected daylight, this instrument is illuminated by the transmitted electric light of the handle of the Mor-

ton-Inskeep ophthalmoscope or of the Würdemann transilluminator. The source of illumination is thus constant.



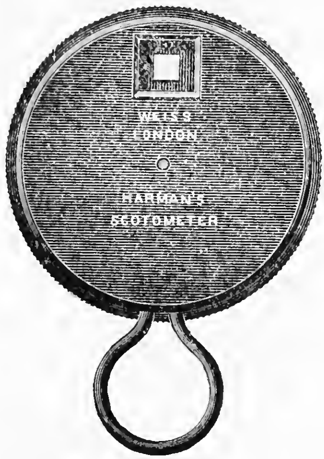
Bardsley's Scotometer.

As the accompany illustration shows, the scotometer consists of two superimposed discs, the front one having five apertures in it, gradu-

Scotometer of Birch-Hirschfeld.

ated from 1 mm. down to 0.3 mm. The posterior disc carries one plain and four colored glasses, red, green, blue, and orange.

The two discs can be rotated independenly by their milled edges, so as to vary the size of the aperture or the color presented to the patient.



Bishop Harman's Pocket Scotometer.

The simplest method of examination for a scotoma or contracted field is made in the dark room with a dim diffuse light, just sufficient for the patient to see and fix the observer's eye at a little over half

Thomson Henderson Scotometer.

a metre. The small beam of light from the instrument is then thrown on the patient's eye and moved around the field of vision.

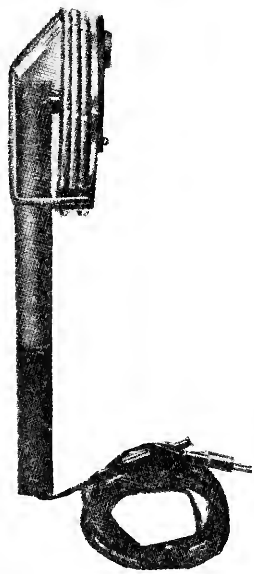
The procedure is, in fact, similar to that of testing the field of vision

by hand movement, but this method, while being equally simple, is far more accurate and delicate.

To chart the field the inventor uses the Maddox vertical and horizontal tangent (1 metre) scale mounted with a small point of light fixed at zero as a fixation point. An extra "lead" from the accumulator of the ophthalmoscope handle supplies the light to the fixation point.

The principle is, of course, that of Bjerrum's test, but simpler, while the object presented to the patient is smaller.

H. Maxwell Landon's scotometer (*Annals of Ophthalm.*, p. 595, July, 1912) is a small edition of the carrier of a perimeter with two



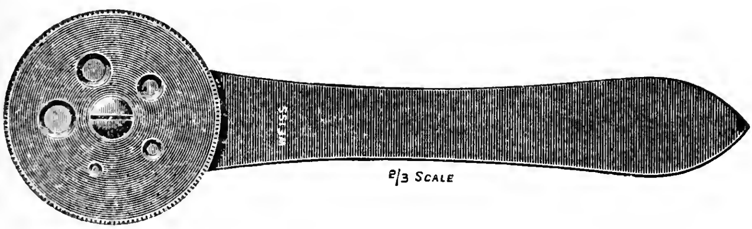
Illuminated Scotometer. (Pearson.)

revolving discs, one for the colors and the other with apertures varying from 1 to 10 mm.; it is on a jointed handle and is intended for use with any nonregistering perimeter, a hand perimeter or on a flat surface as in Bjerrum's method of scotometry.

John Pearson (*Ophthalmoscope*, July, 1914) has designed an instrument useful both as a *scotometer and for testing color-vision.* One of its advantages is its portability, for it can be carried in the coat pocket. The accompanying illustration gives a general idea of the instrument. It consists of four circular superimposed discs, each having a number of apertures. Two of these discs are each fitted with glasses of the following colors: violet, minus red, signal green,

orange, red, and white. This duplicating allows of the mixing of these colors. A third disc is fitted with neutrals of various shades and with ground and corrugated glass after the manner of Edridge Green's color lantern, to represent atmospheric conditions. The fourth disc has diaphragms varying in size from 0.5 mm. to 13 mm. The illuminant is a small electric incandescent lamp fitted in the handle, the light from which is reflected by means of a mirror, so as to pass through the uppermost opening. A + 10 D. sph. lens in front of this renders these rays approximately parallel. By means of letters engraved on the discs the required colors and neutrals are easily placed in position and retained accurately by spring clips. Those possessing a battery-in-handle electric ophthalmoscope can readily adapt the battery and lamp to this instrument.

Ridley's scotometer is figured in the text and presents a simple rotating disk mounted on a handle.



Ridley's Scotometer.

Priestley Smith (*British Med. Jour.*, March 17, 1906) has devised a scotometer intended chiefly for the diagnosis of glaucoma, but, like other perimeters, is equally available for mapping out the visual fields in other diseases. It consists essentially of a disc of millboard covered with black cloth and figured on the back with the degrees of the circle. The test object is a small cutting of gray wool which is laid upon the cloth at any desired distance from the center. In the case of suspected glaucoma it should be placed at 25° from the center, as shown by a faint mark on the cloth, and the disc should then be slowly rotated. Should it nowhere disappear or grow dim, in all probability glaucoma does not exist, for, as Bjerrum has shown, the defect in the glaucoma field is almost always radial or sector-like, and, with a delicate test could be traced inwards. If a defect is found its extent should be noted on the graduated circle so that it can be used for future comparison. Other circles may be explored if necessary.

Scotommeter. (More properly written *scotomometer.*) A name given originally by G. Ferdinands (*Brit. Med. Jour.*, p. 741, ii, 1890) to an

instrument for detecting scotomata, consisting of three superposed discs pivoted at the centre. On one of them the colors red, green, yellow, and blue are painted; the second has four square apertures of graduated size; and the third has one aperture. By rotating the second disc any of the colors can be exposed, and by rotating the third disc the extent of colored surface exposed can be regulated. See **Scotometer.**

Scotopia. Darkness vision; twilight vision; state of low-light adaptation of the retina.—(C. L. F.)

Scotos. (L.) Amblyopia.

Scotoscope. A night-glass.

Scotoscopie. (F.) Skiascopy or the "shadow test."

Scotoscopy. Same as skiascopy.

Scotosis. (L.) Amblyopia.

Scototherapy. Treatment of disease by the complete exclusion of light-rays.

Scott's mixture. See **Hydrastis,** p. 6075, Vol. VIII of this *Encyclopedia*

Scott, John. A British surgeon of considerable repute in the treatment of diseases of the eye. Born at Bromley, Scotland, in 1798, he studied for a time at St. Thomas's Hospital, London, but later in Edinburgh, where he graduated. Returning to London, he became. in 1828, surgeon to the Ophthalmic Dispensary, and a few years later assistant surgeon to the London Hospital. He died at Brighton, April 11, 1846.

A fairly good teacher, a slow and rather unsuccessful operator. Scott was nevertheless a cautious observer and a writer of valuable articles on general medicine and surgery. His only ophthalmic writing was a work of no importance, entitled *"Cataract and Its Treatment"* (pp. 72, London, 1844).—(T. H. S.)

Scott, Kenneth Mackenzie. A well known professor of ophthalmology at the Egyptian Medical School, Cairo. Born at Morton, Bingley, Yorkshire, he received his training in the liberal arts at the Edinburgh Academy, Edinburgh University, and King's College, London. His degree of bachelor in medicine was received at Edinburgh University in 1887. His ophthalmic training was obtained in Moorfield's and he was House Surgeon at the Gray's Road Inn Hospital. He was ophthalmic surgeon to the Kasr-el-Aini Hospital, Cairo, from 1889 to 1899. He was also one of the organizers of the Cairo Blind School. Removing to London, he became assistant ophthalmic surgeon to the West London Hospital and Consulting Ophthalmic Surgeon to St. Mary's Hospital for Women and Children. His writings are mostly on refraction and lid operations. He died in London, suddenly, on Feb. 19, 1918.—(T. H. S.)

Scott, Xenophon Christmas. A well-known American ophthalmologist and oto-laryngologist. Born at Hayesville, Ashland Co., Ohio., Dec. 4, 1842, he received his training in the arts and sciences at Jefferson College, Cannonsburg, Penna., receiving the degree of A. B. in 1865, and that of A. M. in 1868. After two years service in the Civil war as a private soldier, he began to study medicine in 1864, under Dr. John Weaver. Later he studied under Dr. D. H. Scott, and at the Cleveland Medical College where he received his degree in 1867. For the next two years he was resident physician and surgeon at various New York and Brooklyn hospitals. In 1869 he received the degree of M. D. *ad eundem* from the College of Physicians and Surgeons, New York. He then studied diseases of the eye, ear, nose and throat at Heidelberg, Berlin and London. While in Heidelberg, he was for a time first assistant ophthalmic surgeon at the University Eye Hospital.

Returning to New York in 1871, he was resident surgeon for one year in the New York Ophthalmic and Aural Institute. The following year he removed to Cleveland to accept the chair of ophthalmology and oto-laryngology, a position which he held until his death.

In 1872 he founded the Cleveland Eye, Ear, and Throat Institute, of which institution he was for many years the surgeon-in-chief.

He was a skilful operator and a good teacher, but neither a great nor a very prolific writer.

He died late in 1909.—(T. H. S.)

Scoünophora vermiculata. See p. 3101, Vol. IV of this *Encyclopedia.*

Screen test. DUANE'S TEST. As is well known, normal eyes bring about stereoscopic vision when used together and binocular single vision results. There are many tests for the fact and the degree of binocular fixation. The amblyscope (q. v.) is one of the most important of these means but there are many other similar devices, for example Duane's screen, cover or parallax test is one of these. That author describes it as follows: "If there is any noticeable deflection behind the screen, the *screen-test is applied in a second way* or by *binocular uncovering.* This procedure consists in covering the left eye and then uncovering both eyes and noticing the movements that take place. If, on thus uncovering the left eye, the right eye remains steady and the left moves into position, the patient has binocular fixation, and the deflection was a heterophoria and not a squint. If, however, the right eye should move out of its position and the left eye should move into place, there is a squint and the left is the fixing eye. If neither eye moves, there is a squint and the right is the fixing eye. By repeating this experiment with each eye alternately the examiner can tell whether there is an habitual binocular fixation, an alternating fixation, or a uniocular squint."

Screen protector. J. R. Cravath (*Electrical World*, p. 1177, May 31, 1913) fully describes this rather recent development of ocular hygiene. He says that in a number of assembly rooms there are white walls back of the platform used for showing lantern slides when occasion demands. Moreover, in a number of concert halls use is made of a sound shell over the platform, this shell being frequently painted a very light color. In many cases these white surfaces are highly illuminated even when they are not being used for lantern slides. Under some conditions such highly illuminated white surfaces in front of an audience may cause considerable eye discomfort. The amount of such discomfort will generally depend on the relative surface brightness of the screen or sound shell and of the surroundings of the screen or sound shell which are within the range of vision of the eyes looking toward the stage.

The cause of this kind of eye discomfort is not so much the intrinsic surface brightness of the screen or sound shell back of the stage as it is the contrast in surface brightness between such a screen or shell and the stage surroundings. The remedy is either to decrease the surface brightness of the screen or shell behind the platform or to increase the surface brightness of the surroundings. As surface brightness depends upon the amount of light falling on a surface less the amount of light absorbed by the surface in question, the surface brightness can be altered either by changing the amount of light directed toward the surface or by changing the color of the surface, or by both methods. Whether either one or both of these remedies should be used depends, of course, upon the circumstances of the case under consideration.

Chicago audiences have two excellent opportunities to see the effects here spoken of. In the concert room known as Orchestra Hall the sound shell back of the stage was originally finished in a very light color. This sound shell is always highly illuminated during performances, and a very noticeable difference in the comfort of sitting through an evening in this hall depends on whether the general lighting of the hall is almost extinguished or whether there is enough general lighting to reduce the uncomfortable contrast between the light-colored sound shell and its surroundings.

Another example is the auditorium of the Western Society of Engineers in the Monadnock block. This is illuminated by lamps placed above a skylight and equipped with reflectors so pointed that very little light shines in the eyes of those in the audience. Nevertheless, it was felt by many that something was wrong with the lighting of this room. It was at last concluded that the trouble came from the highly illuminated white wall back of the platform. The platform

illumination was equipped with a trough reflector concealed back of a ceiling beam just in front of the platform. In order to give plenty of light on the speaker, enough lamps were provided in this trough to make the surface brightness of the white screen back of the platform very much higher than the surface brightness of the surroundings.

The directors finally authorized the purchase of a curtain which could be drawn across in front of the white screen when the screen was not in use for the stereopticon. The relief which the eye experiences when this curtain is pulled across in front of the white screen after the screen has been exposed for a time is very noticeable and is a matter of common comment. This curtain is of a medium tint, being neither very light nor very dark. Its sole purpose is to reduce the contrast in surface brightness between the screen in back of the platform and the surroundings. This it accomplishes very well and much to the comfort of Chicago engineering audiences.

Scrofula. Tuberculosis of the lymphatic glands in early life. Often, also the joints and bones are attacked resulting in slowly suppurating abscesses and fistulæ, the structures attacked being subject to caseous degeneration.

The affections once called "scrofulous" and "strumous" are known to be modified or attenuated tuberculosis. See **Struma.**

Scrofula, Infantile. See **Scurvy, Infantile.**

Scrofuloderma. Any skin eruption of tuberculous origin, generally marked by irregular, superficial ulcerations. There are *papular, pustular, granulomatous* and *verrucous* forms.

Wätzold (*Zeitschr. f. Augenheilk.*, p. 320, 1912) has written upon the relations of this disease in ophthalmic practice. He says that scrofuloderma is of frequent occurrence in dermatology and surgery, but a rare affection of the lids, and describes three cases. In the fold between the lower lid and cheek immediately below the medial canthus a pustule develops and grows subcutaneously and cutaneously to the size of a pigeon's egg, generally without inflammatory symptoms. At first it is movable under the skin and tough; gradually it becomes softer, gains in height and is sharply-defined from the surroundings and from the healthy skin by a narrow inflamed red ring. Later the skin breaks in the center and an ulcer forms on a necrotic base.

The microscopic picture shows typical tuberculous granulation tissue, accumulation of leucocytes with destruction of the nuclei, edematous infiltration and extensive formation of tubercles with numerous giant cells at the margin of the large focus. Tubercle bacilli are scanty. Healing is much retarded and terminates in bridge-shaped scars. In the writer's cases a connection with the tear-sac could be

proven. In children, which are chiefly affected, tuberculosis of the cervical glands occurs, they are swollen, but not painful. For *treatment* excision of the growth well into the surrounding healthy tissue is recommended, as well as curetting the tear-sac with a sharp spoon, followed by insertion of iodoform and closure of the wound by sutures.

Masuda (*Am. Journ. of Ophthalm.*, Jan., 1918) reports an acute disseminated choroiditis with scrofuloderma. A fifteen year old scrofulous patient had hemorrhagic nephritis with a suppurating lymphatic gland of the neck, which had partly cicatrized and had given rise to typical scrofuloderma in its neighborhood. Chemosis and swelling of the eye-lids appeared in each eye, which was accompanied by dull pain. Ophthalmoscopic examination showed pale-yellowish spots, which were more or less round, and a few of which were the size of the papilla. These spots were not accompanied by pigment and lay under the retinal vessels. They were more frequent in the equatorial zone, leaving the neighborhood of the papilla and macula free. The affection was more pronounced in the R. eye than in the L. It was interesting to note that the fundus disease appeared and proceeded with the swelling of the eyelids. The writer thinks that this form of choroiditis has not yet been described, and calls it acute disseminated choroiditis with scrofuloderma.

Scrofulous conjunctivitis. Scrofulous ophthalmia. A form of chronic conjunctivitis attributed to "scrofula"; characterized by phlyctenulæ, by miliary nodules in the region of the cornea, or by serpiginous ulceration of the cornea. See p. 3131, Vol. V of this *Encyclopedia.*

Scrofulous keratitis. See p. 6798, Vol. IX of this *Encyclopedia*

Scrofulous ophthalmia. See p. 3131, Vol. V of this *Encyclopedia.*

Scurvy. Scurvy, hemophilia and purpura constitute a category of diseases of obscure etiology that are grouped under the general name of the hemorrhagic diathesis. The three disorders are more or less related to one another; hemophilia in most cases being attributable to an hereditary transmission of a tendency to bleed and being a permanent condition, whereas scurvy and purpura are always acquired; the former appearing endemically, the latter sporadically; the former usually as the result of malnutrition, the latter rarely dependent upon definite external conditions. Even in scurvy and purpura, however, one is almost forced to the conclusion that a congenital predisposition to hemorrhages exists.—(A. C. C.)

According to Parsons (*Pathology of the Eye*, p. 1319) ocular hemorrhages are not uncommon in these diseases. About 3½ per cent. of patients suffering from scurvy have eye diseases, including interstitial

keratitis, ulcer of the cornea, hyphema, retinal hemorrhage, neuroretinitis, choked disk, orbital hemorrhage, xerosis, night-blindness, etc.

The most important item in the conduct of such cases is, of course, the treatment of the underlying dyscrasia—the scurvy. Croftan (Wood's *System of Ophthalmic Therepeutics,* p. 274) says that the food factor is most important in the treatment of scurvy. The absence of sufficient potassium salts, the lack of sufficient vegetables and fruits, the lack of sufficient fat have all been accused of producing the disease. In the practical treatment of the disorder, at all events, fresh vegetables containing abundant potassium salts, viz.: chiefly potatoes, spinach, cabbage, watercress, turnips, carrots, onions, artichokes, oranges, asparagus, and in addition milk, fresh meat, containing blood, and meat extracts should above all things be abundantly supplied. Combined with rest in bed this diet, as a rule, without further medication, suffices to cure all cases of scurvy in adults or in children.

Prophylaxis is of course very important. Lemon juice abundantly administered is a useful measure. Ideal hygienic conditions with plenty of fresh air, abundant light and a dry domicile are important elements. Of medicines horse radish *(herba cochleariæ)* is popular. Tannic acid, quinine, yeast (200-300 gm. daily) have all been recommended.

The treatment of surface hemorrhages and of the gums consists chiefly in the application of styptics and thorough cleanliness; chief reliance should be placed upon the correction of the underlying taint; with the later removed, the hemorrhages will stop of their own accord.

Scurvy, Infantile. INFANTILE SCROFULA. BARLOW'S DISEASE. SCURVY-RICKETS. See, also, **Scrofula** and **Scurvy.**

K. Steindorff (*Zeitschrift für Augenheilkunde,* xxv, p. 180, 1912) has reported a case of Barlow's disease with eye symptoms.

In this case infantile scurvy was present side by side with rickets, an unusual association. The 7-months'-old child was brought to the clinic on account of a bluish-red swelling of the left upper lid. There was also a small, bluish discoloration of the right upper lid at the inner canthus. There were small gingival hemorrhages. Backward pressure on the eyeball caused lively demonstrations of pain. Swelling over other parts of the bony system were absent. On the other hand there were typical rachitic symptoms, including a decided "rosary." A small fugitive hemorrhage occurred in the left conjunctiva, but there were no retinal hemorrhages. The child had been fed since birth on pasteurized milk, which the too solicitous mother had

further subjected to fifteen minutes' boiling. Recovery was steady and complete under the use of unboiled milk with oatmeal gruel. The case was exceptional in the coexistence of rickets, in limitation of the bone symptoms to the orbit and lower jaw, and in the fact that the child belonged to the proletariat.

Dewey (*Oph. Year-Book*, p. 410, 1912) reports a case in an infant 11 months old; had a swelling and discoloration of the lid, exophthalmos, and ecchymosis of the bulbar conjunctiva. The child had been given six of the different kinds of infant foods. It was extremely pale and anemic. It was placed on a diet of raw cow's milk, baked potatoes and beef juice. Five days later the physicians expressed themselves as "having never seen such a remarkable change in a case." Ten days after that there was no sign of disease.

Exophthalmos in Barlow's disease is the subject of a paper by L. R. DeBuys (*Journ. Am. Med. Assocn.*, Dec. 7, 1912). He states that a committee of the American Pediatric Society reported that in 379 cases swelling and protrusion of the eye was noted in forty instances. Heubner, in his collection of sixty-five cases, states that the orbit was involved four times; and Jacobi, in forty cases, four times.

The case of Magnus (1878) is probably the first report of exophthalmos in scurvy.

The exophthalmos may appear in one or both eyes, beginning in one and involving the other subsequently. It comes on suddenly and causes a displacement of the eye forward, downward and outward. There may be an improvement, the eye returning to its normal position, to be followed by a recurrence (Magnus, DeBuys); or the eye may remain stationary, and at intervals the symptoms increase (Jacobi, DeBuys). If the hemorrhage extends in front of the fascia orbitalis there may be an associated ecchymosis and suggillation, the upper lid becoming discolored and puffy, caused by the infiltration of blood into the loose connective tissue of the lids; or the exophthalmos may exist as the sole evidence of hemorrhage into the loose areolar tissue within the orbit, or of subperiosteal hemorrahge within the orbit, providing the hemorrhage does not extend in front of the fascia orbitalis. This symptom is usually a late manifestation in scurvy, though it has been noted as being among the earlier evidences (Schlesinger); and Barlow has described a case in which the exophthalmos was the only symptom of the disease.

Proptosis or exophthalmos should not be confounded with the conditions more frequently found when there is actually no displacement, but the ecchymoses and suggillations are in the soft tissues in front of the eye, and hemorrhage under the conjunctiva, giving the effect of

a displaced eye. In these conditions the tissues may become so much involved as almost to close the eye, whereas in exophthalmos the aperture of the lids is much wider than normal and the eye is seldom completely covered by the lids.

In injury of the eye producing a proptosis or exophthalmos, besides the history of the injury there are wanting the other evidences of scurvy, and the therapeutic test will clear the diagnosis.

In malignancy there is not the sudden swelling; the motility of the eye is impaired in extreme cases; the evidences of scurvy are not present, and antiscorbutic treatment also has no effect.

Gumma of the periosteum within the orbit my produce an exophthalmos, but the onset is very slow and gradual.

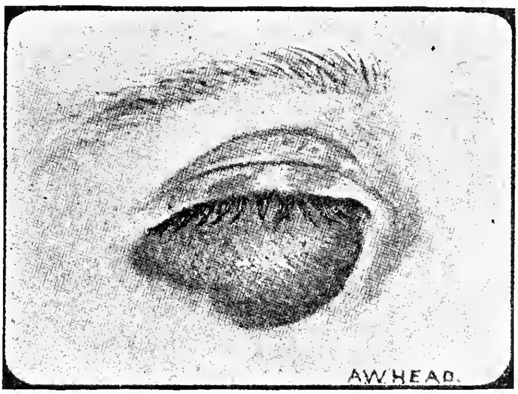
Mucocele, encephalocele and hydrocephalus may give rise to a displacement of the eye, but there are enough other symptoms in these conditions to permit a differential diagnosis.

Barlow states that he is of the opinion that in no disease, even syphilis, is the therapeutic test of more value than in scurvy. In making a therapeutic diagnosis should there be no improvement in four or five days, the diagnosis should be questioned.

Sydney Stephenson (*Ophthalmoscope,* p. 132, March, 1915) gives a full account of certain aspects of the ocular manifestations of infantile scurvy. He states that the commonest sign is in reality a dual one, consisting of (a) protrusion of the eyeball, and (b) hemorrhage beneath the skin of the eyelids or neighboring parts. It is true that the two elements may occur independently of one another, but in most cases they are conjoined. To judge from the 379 cases of infantile scurvy collected and analyzed by the American Pediatric Society in 1898, the sign cannot be called exactly a common one, since it was found in about 10 per cent. of the cases only. In 9 of the 49 cases swelling of the lids was present; in 18 proptosis; and in 22 both signs were noted. Blood-staining of the eyelids was present in 11 per cent. of the 54 personal cases of infantile scurvy brought together by G. F. Still some years ago, and in 5 out of the 6 cases was associated with protrusion of the eye. Huebner reported orbital hemorrhage four times amongst 65 cases, or 6.15 per cent. On the other hand, Nicolay (quoted by F. Schlesinger) found orbital hematoma in 49 of 372 patients, or no less than 13.17 per cent.

The proptosis may range from so slight a change that it has to be looked for carefully in order to be identified, to one that strikes the observer in a moment. It must, however, be rare indeed for it to attain such dimensions as to lead to loss of the eyeball from exposure and sepsis of the cornea.

Similarly, the effusion of blood may be represented merely by a line or patch of blood-stain in the eyelids (usually the upper lid) or in the close vicinity of the orbit, to a large protrusion of the eyelid by blood. These cutaneous or subcutaneous hemorrhages are usually due to an effusion of blood between the periorbita, on the one hand, and the bones of the orbit, on the other, and that accounts for the frequent co-existence with proptosis, owing to the same cause. It was shown by Thomas Barlow that the painful bone manifestations that usually form so prominent and early a feature of infantile scurvy were due to the sub-periosteal effusion of blood. That a similar explanation applies to the eye changes is shown by Snow's case, in which the blood



A Case of Infantile Scurvy. (Stephenson.)

lay between the periorbita and the bone and filled almost the entire orbital cavity.

It has been noted by more than one writer that proptosis and ecchymosis may occur with great suddenness, usually after a fit of crying.

There are a few other hemorrhagic manifestations of infantile scurvy that should be enumerated.

The first mention of subconjunctival hemorrhage that the writer has been able to find was in cases by Shoppee and R. J. Godlee respectively, the details of which were published in 1883 by Barlow.

Hirschberg has related an otherwise typical instance of scorbutus in an infant of nine months, where, as the signs of a large orbital hemorrhage were subsiding, flame-shaped hemorrhages were found in the retina, to say nothing of subconjunctival hemorrhages.

Lastly, blood in the anterior chamber of the eye has been seen by Otto Katz.

The recognition of the cause of the various conditions spoken of above is, as a rule, simple enough. An infant who screamed almost the moment the doctor entered the room, whose lower limbs could scarcely be touched without agony to all concerned, whose gums were spongy, bleeding, and of evil odor, and who likewise presented a livid or swollen eye, could only be affected with infantile scurvy. A difficulty might arise when the ocular antedated all other signs of scorbutus. Even then, in order to avoid error, we have but to recall the familiar caution, namely, that a black or protruding eye during the first dentition, not due to injury, is much more likely to be caused by scurvy than by anything else.

Scurvy-rickets. See **Scurvy, Infantile.**

Scyphus in oculo. LAPIDEUS IN OCULO. (L.) Ancient terms applied to a cup-like calculous concretion in the eye, corresponding probably to ossification of the choroid.

Sea-hedgehog. See **Sea-urchin.**

Sea-leek. See **Squill.**

Seals, Oculists'. Mortimer Frank (Wood's *Sys. of Ophth. Oper.*, p. 21, Vol. I) states that ophthalmology as a specialty among the Romans declined as soon as it was found "that there was no money in it." The rush for a lucrative medical practice was immense, particularly as from the outset it was governed by the laws of free-trade and the door flung wide open to the ignorant and impure elements of society.

The Roman oculists eventually became mere concocters of eyesalves. Their ointment-pots and business stamps have been found in almost every land where the Roman legions were stationed or the Roman eagles flew. Trachoma must have been very frequent among the Roman soldiers inasmuch as copper sulphate is one of the ocular remedies most frequently spoken of. That so many stamps or seals have been preserved probably depends upon the fact that all ophthalmic diseases, including errors of refraction, were treated solely by medication. The collyria of the ancient Romans bore, like our toilet soaps, the stamp of the proprietor or inventor. The vessels in which these collyria and eyesalves were stored, and even the remedies themselves bearing the stamps in question, have been discovered in great numbers throughout Germany, England and France, especially in localities where the permanent camps of the Roman legions were pitched. See, also, **History of ophthalmology.**

Seamen, Examination of the eyes of. See **Eyes of soldiers, sailors, railway and other employees, Examination of the.**

Sea-onion. Also called, sea-leek. According to Dioscorides and Pliny the Elder, a remedy for "weak sight." See **Squill.**—(T. H. S.)

Searching ocular. A low-power eye-piece used in combination with high power objectives.

Sea-scorpion. *Scorpionus rufus marinus.* In ancient Greco-Roman times the gall of the sea-scorpion mixed with oil or Attic honey, was good for hypochyma (cataract) and corneal scars.—(T. H. S.)

Sea-sickness, Ocular symptoms of. Weeks (*Diseases of the Eye,* p. 587) points out that in rare cases cataract develops [probably as one form of *concussion cataract* (see p. 1470, Vol. II of this *Encyclopedia*)] as the result of severe *mal de mer.* The author observed such a case in a woman, aged 34. The patient was at sea two weeks. When she left Hamburg her vision was excellent but on arrival at New York it was greatly reduced. Examination disclosed soft cataract with swelling and almost complete opacity of both lenses.

Sea-snakes. The *Hydrophidæ* are venomous marine snakes, inhabiting the tropical Indian and Pacific Oceans, especially between China and Australia. The body is compressed behind, and the tail is often markedly paddle-shaped; the ventral scales are very slightly if at all specialized; the nostrils are valved, and lie on the tip of the snout; the *eyes* are small, and most of the sea-snakes are very blind and helpless when taken out of the water; the fangs are like those of cobras, and the venom is very virulent.

Sea-urchin. *Echinus.* According to Pliny, a decoction of sea-urchins, viper skins and frogs, taken internally, increases the power of vision. —(T. H. S.)

Seborrhea marginalis. BLEPHARITIS MARGINALIS. See pp. 1022 and 1028, Vol. II of this *Encyclopedia.*

Seborrhea nigricans. COLORED SWEATING. EPHIDROSIS TINCTI. PALPEBRAL CHROMIDROSIS. See **Ephidrosis,** p. 4477, Vol. VI, as well p. 2206, Vol. III of this *Encyclopedia.* Colored sweating—a rare affection—generally affects the lower lid, and is seen as an oily, bluish or blackish secretion that may easily be wiped away. The condition is met with in malingerers, hysterics and in young women suffering from sexual or systemic disturbances.

The term *seborrhea nigricans* has also been applied to the so-called "black heads"—those dark-colored collections in diseased sweat-glands that occur mostly in anemic girls. The condition is best treated by attention to the general health of the patient, the expression of the glandular deposits and the local application of a mixture of liquor plumbi and glycerine.

Seborrhea, Palpebral. Excessive discharge of sebum is observed at times upon the upper eyelid in the dry form and on both lids in the oily form. Here it is not only necessary to use internal treatment,

but local applications, preferably in the form of sulphur ointment or a mixture of equal parts of 5-per-cent. oleate of mercury and precipitated sulphur, mixed with a base of cold cream (unguentum aquæ rosæ).—(J. M. B.) See, also, **Blepharitis marginalis.**

Sebum. The secretion of the sebaceous glands (of the skin); a thick, fatty semifluid substance composed of cellular débris from the Malpighian layer.

Sebum cutaneum. The fatty secretion of the skin. This substance was employed by both Calissen and Himly as an application to the point of a cataract (couching) needle, just prior to its use. Ear wax was similarly employed.—(T. H. S.)

Sebum palpebrale. The secretion of the Meibomian glands.

Secacornin. See **Ergot,** p. 4508, Vol. VI of this *Encyclopedia.*

Secale cornutum. See **Ergot,** p. 4507, Vol. VI of this *Encyclopedia.*

Seclusion of the pupil. Seclusio pupillæ. Annular posterior synechia See p. 6649, Vol. IX of this *Encyclopedia.*

Secondary axes. Lines passing through the centre of a lens or a mirror in a direction oblique to that of the principal axis.

Secondary cataract. Formerly defined to be a cataract which is consequent upon some local disease of the eye, such as irido-cyclitis or irido-choroiditis, glaucoma, detachment of the retina, or intra-ocular tumor. More recently, *after-cataract.* See p. 113, Vol. I of this *Encyclopedia.*

Secondary color. A color obtained by mixing two of the so-called primary colors.

Secondary deviation of the eye. The associated movement made by the healthy eye in strabismus when it is excluded from the visual act, and the patient is made to fix with the squinting eye.

Secondary eversion of the eyelid. Having turned the upper lid and completed its inspection, the surgeon should retain the lid in its everted position and pass beneath it, and into the upper fornix, a Noyes retractor. This instrument is used to expose the entire upper fornix, which is a favorite location for trachoma and foreign bodies. Papillary tumors of the conjunctiva occasionally grow from this part, owing to the irritation caused by the lodgment of a foreign body. To render this procedure painless a few drops of holocain (1-per-cent. strength) can be dropped into the eye. Only rarely does it occur that spasmodic closure of the lids cannot be overcome by the means just described. If so, a general anesthetic will be necessary. While the lids are everted any required application should be made. See p. 4586, Vol. VI of this *Encyclopedia.*—(J. M. B.)

Secondary eye-cup and eye membranes. See p. 3868, Vol. V of this *Encyclopedia.*

Secondary focus. Divergent rays that impinge upon a lens and are brought to a point—the secondary focus. See **Focus.**

Secondary magnification. The process of enlarging the real image formed by a positive lens by means of a second positive lens.

Secondary positions of the eyes. Positions assumed by the eyes when rotated from the functional positions of rest.

Secondary spectrum. The residual chromatic aberration observed when employing an ordinary achromatic lens.

Second intention. Union by the adhesion of opposed granulating surfaces.

Second nerve. The optic nerve.

Second sight. See **Sight, Second.**

Secondi, Ricardo. A well-known Italian ophthalmologist. Born Oct. 23, 1832, at Casale Majocco, in the Province of Milan, he studied at Pavia and Vienna, and settled at first in Pavia. Here he became assistant to Flarer in 1857, but three years later was called to the full professorship of ophthalmology at Genoa. He was a dexterous operator, a widely celebrated teacher, and wrote many papers on ophthalmic subjects. He died in 1903.—(T. H. S.)

Secretion, Lacrimal. See **Tears.**

Secretions, Ocular. This rubric comprises many headings that are treated in numerous places in this *Encyclopedia.* See, e. g., **Tears,** as well as **Circulation of the intraocular fluids,** p. 2256, Vol. III.

Section, Saemisch's. A surgical operation for the relief of corneal complications, especially of hypopyon ulcer. See p. 3454, Vol. V of this *Encyclopedia.*

Sections, Microscopic, of the eye. See **Laboratory technique,** p. 6886, Vol. IX of this *Encyclopedia.*

Sector. (a) A plane figure enclosed between an arc and two radii. (b) A solid generated by the evolution of a plane sector about one of its radii.

Sector-form scotoma. See **Gunshot injuries of the ocular apparatus,** p. 5664, Vol. VII of this *Encyclopedia;* as well as under **Perimetry.**

Sector of a sphere. The solid generated by the revolution of the sector of a circle about one of its radii.

Secundäre Augenblase. (G.) Optic cup.

Sedimentary cataract. An obsolete term applied to the formation of a dense fibrous false membrane giving rise to a secondary cataract.

Seehear. The vulgar name for a device by which the motions and sounds of the heart are rendered audible and visible.

Seele. (G.) Mind.

Seerig, Albert Wilhelm Hermann. A well-known German surgeon, of

moderate ophthalmologic importance. Born at Rudolstadt a. d. Saale, April 26, 1797 (1798), he studied at Jena, Berlin, and Breslau, at the latter institution receiving his degree in 1822. For a time he was prosector in the Breslau Anatomical Theatre, became, however, in 1825, privatdocent, and in 1826 extraordinary professor, at the University. In 1836 he removed to Königsberg in Prussia, in order to accept the chair of ophthalmology and surgery at the University in that place. He died Mar. 7, 1862.

His only writings possessed of any ophthalmologic importance are the following: 1. *Armamentarium Chirurgicum oder Beschreibung Chir. Instrumente Alterer und Neuerer Zeit.* (2 Vols., Bresl. 1835-38.) 2. *Bericht über das Klin. Chir.-Augenärztl. Institut der Universität zu Königsberg, für die Jahre 1836-'44.* (Königs. 1844.)—(T. H. S.)

Segel's test for feigned blindness. See p. 1187, Vol. II of this *Encyclopedia.*

Seggel, Karl. A well-known German ophthalmologist. Born Jan. 7, 1837, at Wassertrüdingen, in Mittlefranken, he studied at Erlangen, Würzburg, Jena and Berlin, taking, at last, his medical degree in 1859 at Würzburg. From 1861 till '71 he was a military physician, much of the time in active service. In 1877 he founded at Munich a military hospital, of which he was also director. He was killed in a street-car accident at Munich, Mar. 2, 1909, aged 72.

He wrote a large number of articles, which appeared chiefly in the "*Archiv für Augenheilkunde*" and in the "*Klinische Monatsblätter.*" The list is much too long for insertion here.—(T. H. S.)

Segment, Rod-. The two segments which make up one of the rods of the retina. The outer rod-segment is the portion presenting a uniform diameter, while the inner rod-segment has a slightly increased diameter.

Sehachse. (G.) Visual axis.

Sehbahnen. (G.) Optic tracts.

Sehfeld. (G.) Field of vision.

Sehhügel. (G.) Optic thalamus.

Sehkunst. (G.) Optics.

Sehlehre. (G.) Optics.

Sehnervenkreuzung. (G.) Chiasm.

Sehnerveneintritt. (G.) Optic disc.

Sehnervenscheide. (G.) The sheath of the optic nerve.

Sehproben. (G.) Test types.

Sehprüfung. (G.) Examination or testing of the vision.

Sehrichtung. (G.) Line of sight.

Sehschärfe. (G.) Visual acuity.
Sehschwäche. (G.) Asthenopia.
Sehsphäre. (G.) Visual centre; corpora quadrigemina.
Sehstoff. (G.) Visual purple.
Sehstörungen. (G.) Disturbances of vision.
Sehstrahlung. (G.) Optic radiation.
Sehursprung. (G.) Visual centre.
Sehwinkel. (G.) Optic angle.
Sehziel. (G.) Horopter.
Seidel's sign. See **Sign, Seidel's.**

Seidlitz, Karl Johann von. A well-known Russian military and naval surgeon, who devoted considerable attention to ophthalmology. Born at Reval, Mar. 6 (17) 1798, he received his medical degree in 1821 at Dorpat. After a period of military service in a surgical capacity, he studied again at Paris, Montpellier, Geneva and Pisa. He was then engaged once more in military service in the Turko-Russian war, then ambassadorial physician at Constantinople, and, from 1837-'47, professor at the Medico-Chirurgical Academy at St. Petersburg. Stieda says of him "He was a man of remarkably clear and sharp intelligence, of great energy and activity." He died Feb. 7 (19), 1885.

Seidlitz's ophthalmologic writings are as follows: 1. De Precipuis Oculorum Morbis Inter Estonos Obovis. (Grad. Dis., 1821). 2. Beitrag zur Geschichte der Agyptischen Augenentzundungen in der Russ. Flotte.—(T. H. S.)

Seip, George W. An ophthalmologist and otologist of Erie, Penna., who received his medical degree at the Jefferson Medical College in 1862 and died Feb. 21, 1902.—(T. H. S.)

Seitenwendungen. (G.) Ocular excursions.

Selection test. A crude and unreliable form of color examination by which different colors are selected at request from a collection of colored objects.

Selective absorption. The process of absorption of some of the constituent rays of an incandescent solid body when passing through a gas at a lower temperature, or through some solids or liquids.

Selenium. An element having two forms. In the *vitreous* form, at ordinary temperatures, it is a solid of a dark-brown color, and when broken presents a conchoidal vitreous fracture; thin splinters of it are, however, of a dark-red tint, when seen by transmitted light. It is tasteless and inodorous, and a non-conductor of electricity. Its specific gravity is 4.28; its melting point is 217° C., and its boiling point 700° C. When selenium is very slowly cooled from the fused condi-

tion its appearance is quite different; the structure being granular or crystalline (sometimes called "metallic"). Crystalline selenium is of a dull-leaden color; it is very opaque to light even in thin films; its specific gravity is 4.8, its melting point 200° C., and its boiling point 680° C. It is a conductor of electricity at ordinary temperatures. Its resistance to the passage of an electric current diminishes up to the point of fusion, but suddenly increases as the selenium becomes liquid. Another property of crystalline selenium, which has recently given it a new interest, is that it is remarkably sensitive to light; and its electrical resistance varies very much according to its exposure to light, being much less in the light than in the dark. When heated in the air selenium does not very readily take fire; but it is combustible and burns with a blue flame, while a portion of it is volatilized in red fumes. The products of combustion are oxide of selenium and selenious anhydride, SeO_2.

Selenium is of rare occurrence in nature; it is chiefly found as a selenide in combination with lead, silver, copper, or iron; but it has also been discovered in sulphur, and in certain sulphides of iron. Chemically it is closely related to sulphur.—(*Standard Encyclopedia.*)

The fact that selenium conducts electricity only in the light was discovered by May and confirmed and reported by Willoughby Smith, telegraph operator at Valencia, as long ago as 1873. It was at once surmised that interesting applications of the anomalous fact might in time be made. Some illustrations of the possibilities were given by William J. Hammer before the American Institute of Electrical Engineers in New York. Hammer fired a cannon over the heads of the audience by throwing a beam of light from a distance; and he operated a five-horse-power dynamo, alternately starting and stopping it at will, merely by waving his hand across a beam of light directed toward a selenium cell introduced in the electric circuit.

Hammer suggested that the cannon of a fort might be so arranged in time of war that the searchlight of a hostile ship would discharge the weapon just at the moment when it was so directed as to send its missile to the ship furnishing the source of light. He suggested also that selenium cells might be arranged in such a way as to make possible direct vision over a telephone wire; not the mere sending of pictures, which is already accomplished by Korn's method, but actual vision of objects, as, for example, the face of the talker at the other end of the telephone wire. It was even reported that Hammer had taken out a patent for such an apparatus; but the instrument has not yet reached the commercial stage. See, also, **Optophone.**

Hearing the "sound" of moonlight appears a fantastic notion without common-sense foundation, but that such a thing is possible is the claim made by Fournier D'Albe, of the Birmingham (England) University, the inventor of the "optophone." At a recent test of the instrument, given in London, the value of the device for blind people was demonstrated.

The optophone (*Popular Mechanics,* Oct., 1915) is a small camera-like box, open at one end, which, if pointed at the light, causes the instrument to produce sound which is transmitted by sensitive receivers of the type used in telephones. A blind man turning around, with the instrument in his hand, can ascertain the location of a window. The different tones and degrees of sound enable the user of the instrument to determine the character of the body passing between him and the light. By aid of the receivers the user is able to count people who pass in front of him by the intervals of light between them. "On a moonlight night," asserts the inventor, "you can hear the moon, and when the sun is shining you would recognize it by the tremendous noise it would make." Besides this use of the optophone, D'Albe expresses confidence that the invention will prove useful in discovering the light of stars that are not visible, as well as in many other directions.

E. Carlo (*Annales d'Oculistique,* Sept., 1913) has investigated the property inherent in selenium of changing its electrical conductivity according to the illumination to which it is exposed. He has endeavored to find out whether this peculiarity can be utilized in clinical photometry, and if so, under what conditions. His experiments showed that exposure of a film of selenium to white light, both with and without previous exposure to sunlight, caused irregular movements of an ampèremeter, but that with monochromatic light and a previous exposure of selenium to light the galvanometric deviations corresponding to moderate illuminations remained almost comparable if the exposure of the selenium to the light to be measured did not exceed ten seconds. Carlo has mapped out curves showing the amount of galvanometric deviation for various luminous intensities, and considers that it is possible within the limits of his experiments to measure the luminous intensities or degrees of illumination of monochromatic radiation objectively at a given point, and from the results so obtained to calculate the intensity of the total white light emitted by the same source, so that there ought to be no difficulty in constructing a clinical photometer.

Selenoplege. Selenoplexia. A morbid condition attributed to exposure to the light of the moon. See **Moon blindness.**

Self-enucleation of the eye. SELF-AVULSION OF THE EYEBALL. See **Automutilation, Ocular,** p. 711, Vol. I of this *Encyclopedia.*

In addition to the instances there described others have been published, a few of which are appended.

Heller (*Oph. Year-Book*, p. 395, 1912) reports three cases. One a birth injury; one a case of self-mutilation by an insane patient, and the third rather a bursting of the eye from its socket, due to compression of the cranium, which fractured the walls of the orbit. In Terson's case, as in others of the same nature, the patient first pierced the conjunctiva with the nails, tore off the eye muscles, and finally the nerve by twisting the globe. Healing was as smooth and rapid as after a typical enucleation.

Although no eye-witness was present, all circumstances point to the assumption, in the case reported by Lundsgaard (*Prac. Med. Series,* Eye, p. 178, 1910), that one insane woman had within two minutes, as they were not longer together, torn out the eyes of another insane woman. One eyeball was lying on the floor, the other was hanging by the internal rectus. The optic nerves were severed at about 4 and 5 mm. from the eyeballs. The writer gives the measurement of the stumps of the ocular muscles left in connection with the globe. According to Axenfeld, the literature contains no authentic instance of one person having torn out the eye of another.

Self-focusing. Focusing without any artificial adjustment.

Self-luminous. Possessing in itself the property of emitting light.

Sella turcica. The pituitary fossa, a deep depression, resembling a saddle somewhat, upon the upper surface of the body of the sphenoid bone which lodges the pituitary body. See **Pituitary disease,** p. 10231, Vol. XIV; and **Intracranial organs,** p. 6547, Vol. IX of this *Encyclopedia.*

Luger (*Journ. Am. Med. Assocn.*, Sept. 6, 1913) states that the *normal limits of the sella turcica,* as shown by roentgenograms, are 15 mm. in the antero-posterior diameter and 10 mm. in the vertical. It is necessary, however, to take into consideration the effect of the other internal secretory glands, especially the sexual organs. While castration is known to cause enlargement, this is opposed to the non-enlargement in the so-called "eunuchoid type," in spite of the many resemblances of the latter groups to true eunuchs. In pregnancy, increase of the sella has been observed, and it is not infrequent in old multiparæ. The condition of the thyroid also must be considered, as enlargement of the sella turcica can be demonstrated in many cases of myxedema. The two commonest varieties—the short and rather deep, and the long and rather flat types of sella—seem to be dependent

in some way on the shape of the skull (Schüller) ; the first was found as a rule in the brachycephalics and the other in the bradycephalics. According to Fitzgerald, the size of the sella always corresponds to the length of the posterior portion of the base of the skull, but it is in indirect proportion to the distance from its anterior wall to the ethmoidal spine. The size of the sphenoidal cells also seems to have some relation. Of course, the X-ray does not show the gland itself, and important conclusions in regard to its disorders can only be deduced from the changes in the bony parts, enlargements and thinnings. The order of appearance of the changes in the sella turcica and its parts, as shown by Erdheim and Schüller, is quite different in cases of tumor of the gland itself from that when an external tumor is pressing upon it. In the former case there is enlargement and thinning from within, and in the latter from without. But in advanced cases it may be difficult to make a differential diagnosis. Intracranial pressure due to tumors having no topographic relation whatever to the gland may also sometimes cause changes. Thus with tumors of the acusticus changes have been observed in the sella—a rather characteristic forward inclination and thinning of the dorsum sellæ—which aid in their diagnosis, especially when occurring with the enlargement of the meatus acusticus described by Henschen.

The condition of this region is important in a number of other eye diseases. For instance, James Taylor (*Br. Journ. of Ophthalm.*, p. 193, May, 1919) by means of radiography shows that the *sella turcica* is abnormal in Leber's disease. This was clearly demonstrated in several cases of hereditary optic atrophy occurring in the same family. The writer reports that in his first case (*Trans. Oph. Soc., U. K.* Vol. 33) the sella turcica as revealed by X-rays was long and shallow and the clinoid processes were certainly not normal. This X-ray photograph was taken within a few months of the onset of the affection. Taylor was able to examine also an older brother of this patient, aged 60, and an X-ray examination of his pituitary fossa revealed a similar and even more extensive change, the fossa being shallow and the clinoid processes much reduced. In his case the visual failure had existed for ten years at the time the skiagram was taken.

It is of interest with reference to the remark Mr. Fisher makes as to the curious symmetry of the fields in Simeon Snell's case, that in this patient also, whose fields were illustrated in the paper referred to, these were in some degree symmetrical. Two other points are noticeable in this family; (1) that in more than one the onset of the trouble was very rapid—almost sudden, without any premonitory symptoms, and the degree of visual failure did not increase, but re-

mained almost what it was in the first few days, and (2) that one of the members of the family was actually under observation at the time at which optic neuritis was present, and that in his case the diagnosis at this time was that of intracranial tumor,—a diagnosis which his subsequent history showed to be almost certainly incorrect.

Semaphone lens. A modified form of Fresnel's lens.

Semaphore charts, Black's. See p. 5082, Vol. VII of this *Encyclopedia.*

Semastat. Fixed sign. See **Phoria indicator,** p. 9648, Vol. XIII of this *Encyclopedia.*

Semastat, Prentice's. An instrument designed to indicate the presence of heterophoria, being a refinement of Prentice's original phorometric chart. It consists of two rectangular tubes, which cross each other at right angles and are perforated in front by a series of electrically illuminated holes, 6 cm. apart. It is a fixed sign, from whence its name, and is to be used at 6 meters' distance from the patient, from whom the information is derived. As to which one of the illuminated green openings is intersected by the line of white or red light produced by a Maddox rod placed before one eye.

Each interval of space between openings is equivalent to a one prism-dioptry deviation. See, also, **Lenses and prisms,** Vol. X, p. 7294, of this *Encyclopedia.*

Semicanaliculus. An example of this very rare congenital anomaly is reported by Ask (*Ophthalmic Year-Book*, p. 311, 1912) in the person of a 13-year-old boy who presented a semicanaliculus just to the inner side of the lower punctum, giving the impression of a slit canaliculus. A probe introduced into the canaliculus raised the depression and showed that it did not communicate with the true canaliculus. He believes that the embryonal massive epithelial cone that finally forms the upper punctum plowed an abnormal furrow in the nasal end of the border of the lower lid.

Semilunar hemorrhage. A term suggested by Herbert Fisher (*Oph. Review,* p. 383, Dec., 1912) to replace that of "subhyaloid hemorrhage." See **Hemorrhages, Ocular**; as well as **Preretinal hemorrhage,** p. 10353, Vol. XIII of this *Encyclopedia.*

Semiptosis. Partial ptosis.

Seneaux, Jean. A well known Monspellensian surgeon, obstetrician and ophthalmologist. Born about 1750, he received the degree of Master of Surgery at Montpellier in 1786, and devoted himself at first to the practice of surgery in general. Owing to his failure to be appointed to the chair of surgery in the Montpellier school, he began, about 1788, to devote himself to ophthalmology exclusively. On March 1, of the same year, he began to lecture on his specialty, but, four

years later, when the law of Aug. 19, 1792, put an end to colleges and universities in France, he was of course obliged to intermit his activities as teacher. When, four years afterward, the school was re-organized, he was not included in the faculty. From this time forward he devoted himself exclusively to obstetrics and pediatrics, and, in a very short time, he was appointed professor of accouchements, diseases of women, and the physical training of children in the Monspellensian University.

He died May 1, 1830, according to Hirschberg, but, according to Truc and Pansier, in the year 1834.—(T. H. S.)

Seneca's microscope. A single magnifying lens, consisting of a glass globe filled with water.

Senecio cineraria. See **Cineraria maritima.** See p. 2251, Vol. III of this *Encyclopedia.*

Sengreen. An ancient remedy for certain eye diseases. See **House-leek.**

Senile cataract. The hard, mature, ripe cataract of advancing years. It usually begins at the periphery and marches steadily toward the centre. See p. 1580, Vol. III of this *Encyclopedia.*

Senile changes in the ocular tissues. See **Age, Changes in the eye due to old,** p. 189, also, **Arcus senilus,** p. 560, Vol. I of this *Encyclopedia.*

A complete histological and histochemical study of the senile changes in the human eye has been presented by Attias (*Oph. Year-Book*, p. 354, 1913), who considered each tissue independently. The commonest change in the cornea was the arcus senilis, which is essentially a fat deposit. Although some hyaline granules could be found in the corneal epithelium, true fat droplets predominated throughout the various corneal layers. In Bowman's membrane and in the corneal stroma, the fat globules could be as easily recognized as in the fixed corneal cells proper. The superficial and deep layers of the corneal stroma first became impregnated with the fat; and eventually the middle layers, although these latter never contained as much as the other two. Fat is never found in Descemet's membrane.

The senile changes in the iris are of a different nature. There is a partial disappearance of the pigment epithelium of the iris at the very margin of the pupil, not due to a retraction, but to an actual loss of cells. This seemed to be more or less associated with a hyaline degeneration of the iris stroma behind and around the sphincter muscle. The posterior epithelial pigment layer at times showed some vacuolated cells. The endothelial changes are of a hyaline character and are not frequent in occurrence.

In the ciliary muscle proper, there was found some true atrophy of

the muscle fibers, but this finding was not a constant one. A general slight increase in fat content, within and around the muscle fibers, was usually present, and a few interfibrillar hyaline changes were seen. More changes were found in the ciliary processes. An actual decrease in the amount of pigment could be shown, together with an actual increase in the amount of fat. The fat droplets were found actually within the epithelium. The extracellular connective tissue was increased in amount, at the cost of the connective-tissue cells. The cause of the lenticular ring, gerontoxon lentis, was discussed in all its aspects and the author believed it to be due to a vacuolation of the nuclei within that zone, rather than to any fat deposits, for a good deal of finely divided fat was found elsewhere in the lens. The extrinsic ocular muscles showed a great deal of intramuscular fat, while the anterior nerves showed a senile degeneration of the myelin sheaths with the accumulation of fat in considerable quantities. De Lieto Vollaro has also written on the cholesterin steatosis of the normal senile eye.

Senile iritis. See p. 6671, Vol. IX of this *Encyclopedia.*

Sens de la vue. (F.) Sense of sight.

Sens des couleurs. (F.) Color-sense.

Sense, Color. The perception of colors; the faculty of distinguishing the various colors. See **Color-sense,** p. 2420, Vol. IV of this *Encyclopedia.*

Sense, Distance. See p. 1119, Vol. II of this *Encyclopedia.*

Sense, Form. The ability to recognize the shape or form of an object. This sense is the foundation or expression of our visual acuity. We really test the degree or sharpness of the sense of form when we use the ordinary test types. See p. 2016, Vol. III of this *Encyclopedia.*

Sense, Fusion. The name applied by Eaton (*Br. Journ. Ophthalm.,* Vol. 3, 1919) and others to the binocular factor in depth perception.

Sense, Light-. The faculty by which we distinguish degrees of illumination or brilliancy. See **Light sense,** p. 7481, Vol. X of this *Encyclopedia.*

Sense of contrast. See p. 3276, Vol. V of this *Encyclopedia.*

Sense, Sixth, of the blind. See **Blind, Sixth sense of the.** See p. 1202, Vol. II of this *Encyclopedia.*

Sense, Space. That combination of the senses (chiefly of sight and touch) which gives us information as to the relative positions and relations of objects in space. See also p. 1119, Vol. II of this *Encyclopedia.*

Sense, Special. Any one of the five senses of seeing, feeling, hearing, taste and smell.

Sense, Stereognostic. The sense by which form and solidity are perceived.

Sensible horizon. The apparent horizon.

Sensitize. To render capable of being affected by the action of light.

Sensitometer. A set of sensitive photographic plates for testing the penetration of the body by light-rays.

Senso di colore. (It.) Color-sense.

Sensory epilepsy. A form of epilepsy originating in the sensory areas of the brain and associated with amaurosis, hemianesthesia, and certain vague movements of the tongue, face, or limbs, but not always with convulsions. An aura is often present, loss of consciousness is the rule, and the patient may gradually become demented, as in ordinary epilepsy.

Sensory reflex. SKIN-REFLEX. When a sensory nerve is stimulated, e. g., as in tickling or pinching the skin, the pupils dilate.

Seo, Dr. A well-known Japanese ophthalmologist, assistant to the world-renowned Komoto. Having studied with Komoto, he practised with him for a time, later, however, in Formosa. Proceeding to Germany for further study, he was, for a short time, with Axenfeld in Rostock and Freiburg. Acquiring tuberculosis of the scrotum, he was successfully operated on by Dr. Kraske; but, returning home, he died in 1902 of pulmonary tuberculosis. At the time of his death he was engaged in writing a text-book on diseases of the eye.—(T. H. S.)

Separation of the retina. See **Retina, Detachment of the.**

Septicemia, Eye affections due to. This subject has been discussed under several headings in this *Encyclopedia.* See, for instance, **Metastasis, Ocular,** p. 7664, Vol. X. As Weeks (*Diseases of the Eye,* p. 765) remarks, both the terms *pyemia* (q. v.) and *septicemia* designate a secondary invasion of the system by organisms of which the chief are the streptococcus, staphylococcus, pneumococcus, gonococcus, colon and typhoid bacilli. The invasion of the eye (through the blood and lymph streams) of the first two generally results in panophthalmitis.

Septic meningitis. See p. 7641, Vol. X of this *Encyclopedia.*

Septoforma. A condensation-product of formaldehyde used as a disinfectant for instruments, in 5 to 10 per cent. solution; as a wash for wounds, in 3 per cent. solution; and in various skin diseases in a 10 per cent. ointment.

Septum orbitale. The anterior (protecting) wall of the eyeball, comprising the tarsi, the canthal ligaments, and the tarso-orbital fascia.

Sera. The plural of *serum* (q. v.). See, also, **Serobacterins.**

Serafiun the Elder. See **Serapion the Elder.**

Serapion the Elder. A Christian physician of Damascus (802-849 A. D.) who compiled in the Syrian language an immense work in twelve books and a smaller one in seven. Both works were soon translated into Arabic, and the shorter one, in various Latin editions, has been known as *Practica, Breviarium, Therapeutic Methodus, and Aggregator.*

The eleventh chapter of the shorter work deals with ophthalmology, briefly but clearly, and under the following heads: (1) Ophthalmia (2) Extravasations (3) Pterygium (4) Pannus (5) Trachoma (6) Falling of the Lashes (7) False Lashes (8) Lid-Lice (9) Cataract (10) Night-Blindness (11) Ulcers. The chapter is not, on the whole, of very great value, but it is often indirectly alluded to as well as expressly cited by later Arabian authors.—(T. H. S.)

Serapis. An ancient Egyptian god (imported from Syria) whose powers of healing seem to have been especially at the command of eye-patients. Numerous ophthalmic remedies of antiquity were called "Serapian."—(T. H. S.)

Serene drop. See **Gutta serena**, p. 5668, Vol. VII of this *Encyclopedia.*

Série de laines. (F.) Holmgren's colored wools test.

Seringue. (F.) Syringe.

Serobacterin. A standardized suspension of bacteria "sensitized" with specific immune serum. Mulford claims for his preparations that they produce active immunity promptly; the dose may be repeated at 24-hour intervals; they rarely cause local or general reactions; they do not cause opsonic or clinical negative phases; they produce durable immunity. The following serobacterins are supplied by this firm in the Mulford aseptic glass bacterin syringe, ready for use: The ophthalmologist is chiefly interested in coli serobacterin (sensitized B. coli vaccine), Neisser serobacterin (sensitized gonococcic vaccine), Neisser serobacterin mixed (sensitized gonococcic vaccine mixed), influenza serobacterin mixed (sensitized influenza vaccine mixed), meningo-serobacterin (sensitized meningococcus vaccine), staphylo-serobacterin (sensitized staphylococcic vaccine), staphylo-serobacterin mixed (sensitized staphylococcic vaccine mixed), staphylo-acne serobacterin (sensitized staphylo-acne vaccine), staphylo-strepto-serobacterin (sensitized staphylo-streptococcic vaccine), strepto-serobacterin (sensitized streptococcic vaccine), and strepto-serobacterin scarlatinal (sensitized streptococcic vaccine scarlatinal).

Serology. Autoserатherapy. Vaccine therapy. Antitoxin treatment. Serum therapy. Seropathy in diseases of the eye. Bacterial therapeutics. Antisera in eye diseases. Although this sub-

ject has been widely discussed in fragmentary fashion under various captions in this *Encyclopedia* (See e. g., under **Tuberculin**) it is proposed to bring the matter to date of writing under the above head.

Serology may be defined as a study of sera in all their relations and actions; and especially as *therapeutic agencies.*

Ernest E. Irons (Wood's *System of Ophthalmic Therapeutics,* p. 182) dealing with the earlier aspects of serum and bacterial therapy remarks that pathological processes of an infectious character, involving the tissues of the eye, follow the same general laws as do infections elsewhere in the body, and aside from certain special secondary features depending on the ocular structures affected, the susceptibility to infection, course of invasion, pathological changes, and mechanism of cure conform to those of infections of the viscera or other parts of the body. Moreover, the ocular manifestation is often only a part of a more or less widely spread general infection, against which remedial measures must be directed. Even in those instances in which the infective process is limited to the eye, the body often shares to some extent in the intoxication, and through the reaction of its cells and tissues, forms substances which, reaching the focus of infection by way of the circulating blood and lymph, assist in the limitation of the disease.

Our present conception of infectious processes, and the mechanism by which they are terminated, either spontaneously or by the intervention of antibacterial or antitoxic sera, etc., is based on certain principles which may be grouped under the general topic of immunity. See p. 857, Vol. II of this *Encyclopedia.*

Ehrlich's side chain theory accounts more completely and satisfactorily than any other for the phenomena observed in immunization, although it too leaves a number of facts unexplained. Ehrlich assumes that the body cell consists of a central atom-group, with a number of side groups which have the power of combining with food stuffs, etc. These latter are called receptors. Some of the receptors which have a single combining group are concerned in the assimilation of the simpler food stuffs and are called receptors of the first order. Other more complex receptors have two unsatisfied combining groups, one for the food molecules and the other for a ferment. These are called receptors of the second order, or amboceptors. In the production of diphtheria antitoxin the theory assumes that the toxin molecule after injection unites with a receptor of the body cell. This receptor being no longer of service to the cell in the assimilation of food is cast off into the circulating blood and a new receptor is formed to take its place. This second receptor is likewise joined by a toxin mole-

cule and the combination is cast off by the cell. Following the general biologic principle that regeneration usually goes on to over-regeneration, the receptors continue to be formed and cast off by the cell, so that not only are all the toxin molecules united to receptors but there is a large number of uncombined receptors circulating in the serum. It is these free receptors which constitute the essential portion of the antitoxin. This theory is further extended to explain the production of the immune bodies of antibacterial, hemolytic, and other immune sera. In these, however, the exciting bodies corresponding to the toxin are more complex in molecular structure, and the antibodies are derived from the receptors of the second order, the amboceptors.

In addition to antitoxins the injection of bacteria or their products into the animal body results in the formation of a number of other bodies, the nature of which is only partially understood. The well-known Gruber-Widal reaction may be taken as typical of the phenomena exhibited by agglutinins. If a small portion of the serum from a patient suffering from typhoid fever, or from an animal which has received injections of typhoid bacilli, is added to a suitable suspension of typhoid bacilli the organisms after a time lose their motility and collect together in clumps. This agglutination phenomena may be demonstrated in the case of many species of bacteria and with certain exceptions is specific for each organism, so that it has come into extensive use in diagnosis. Another class of bodies in immune sera is that of the bacteriolysins. If the bacteria employed in the agglutination reaction are observed closely they are seen to become granular and partially dissolve, and on transfer to favorable media are no longer capable of growth. This bacteriolytic process was first demonstrated by Pfeiffer, working with the cholera spirillum. It appears probable that a number of the antibacterial sera owe their curative properties to the bacteriolysins which they contain.

Precipitins constitute still another class of bodies found in immune sera. If a portion of immune serum is added to a clear bacteria-free filtrate of a culture of the immunizing organism the mixture becomes cloudy from the formation of an albuminous precipate. This reaction does not appear when normal serum is used and has been shown to be specific for each organism. Finally one other class of bodies, the opsonins must be mentioned. These are present in both normal and immune serum and by their action on bacterial and certain other cells render these more susceptible to phagocytosis.

Prophylactic and curative sera, bacterial vaccines, and the specific diagnostic serum and bacterial reactions, with a few exceptions, are

still in the experimental stage. Certain of these no doubt will prove of great value; others will be shown to be inadequate or unreliable as have others before them. The advances of the past few years have been so rapid that the discussion of serum and bacterial therapy at the present time must necessarily be limited to a statement of the trend of scientific and clinical research, outlining those procedures which give most promise of permanency and avoiding dogmatic statements, even at the risk of leaving the reader at times uncertain as to the exact value of a test or of the potency of a remedial agent.

By far the most successful and widely known of the specific sera is *antidiphtheric serum,* the general employment of which has reduced so remarkably the mortality in diphtheria. Its use in diphtheric infections of the eye has been attended with the same favorable results as in cases of the ordinary pharyngeal and nasal infections. Antidiphtheric serum has been used also, empirically, in the treatment of various suppurative lesions not due to the diphtheria bacillus, such as corneal ulcer of pneumococcal origin, purulent conjunctivitis, hypopyon, etc., with reported benefit. These reports, however, are in the main of isolated cases, and it is probable that just as favorable results might have been obtained had other therapeutic measures been employed.

Antitetanic serum, similarly to antidiphtheric serum, is obtained from horses immunized to increasing doses of the tetanus toxin. The greatest value of antitetanic serum lies in its prophylatic use in lacerated and deep puncture wounds in which experience shows that tetanus infection is likely to occur. Cases in which tetanus develops following lacerated or other wounds when the early prophylactic injection of a suitable dose of tetanus antitoxin has been made, are extremely rare. In cases which come under treatment after the symptoms of tetanus have appeared, the injection of the serum locally, intraneurally or by lumbar puncture is indicated. Many cases have undoubtedly been saved by its use, the beneficial results depending on the early neutralization of the toxin, before it has become widely diffused throughout the nervous system. See, also, **Tetanus.**

Antistreptococcic serum. The diphtheria and tetanus bacilli produce soluble toxins, which can be used in the immunization of animals with the resulting formation of antitoxins. In the case of certain other bacteria such as the streptococcus, staphylococcus, pneumococcus, and gonococcus, the toxins are to a large extent at least, intracellular, and much greater difficulty is experienced in obtaining their corresponding immune sera. Moreover, different strains of streptococci vary greatly in virulence among themselves for the same

animal, and different species of animals may exhibit wide variations in susceptibility to infection by any one strain. Several strains of virulent streptococci are usually employed in the immunization of animals, and the antistreptococcic serum produced is thus polyvalent. Antistreptococcus serum has been used in a large number of cases of cellulitis and other streptococcus infections, and many favorable clinical results following its use are on record, including severe infections about the face and eyes. There is a constant tendency however to report favorable cases, while the large number of cases not responding to treatment pass unnoticed. Moreover, the clinical course of streptococcus infections is proverbially uncertain, and, as in pneumonia, this fact has led clinicians to attribute cures to the most diverse empirical remedies. For this reason it is advisable to exercise caution in accepting the favorable reports on the use of antistreptococcic serum, although it must be admitted that the serum has a certain claim for recognition as a scientific attempt at specific therapy.

Especially has the *antimeningitic serum* of Flexner been employed in the treatment of epidemic cerebrospinal meningitis. In the analysis of 400 cases (1908), Flexner found an average death rate of 25 per cent. In cases receiving the serum on the first to the third day, the mortality was 14.9 per cent., while in cases treated first after the seventh day the mortality was 36.4 per cent. These cases occurred in widely separated epidemics, and the average mortality is decidedly lower than has been found heretofore under symptomatic treatment.

Antigonococcic serum. Torrey has likewise advocated the use of the serum of sheep immunized by injections of the gonococcus in the treatment of gonococcus infections. An analysis of the data thus far obtainable indicates that, in general, but little benefit follows the use of the serum in gonococcus infections of the mucous membranes including the conjunctiva. In the deeper localizations such as arthritis the results are somewhat more encouraging. Several cases of gonococcus iritis have shown improvement after the serum, and though the results are not uniformly good, they appear to justify further trial.

Antipneumococcic serum has received an extensive trial in pneumococcal infections. In lobar pneumonia, and other general infections, the results have not been encouraging. Isolated cases, and in some instances small series of cases have been reported in which recovery followed the use of the serum, but the consensus is that its value in this class of cases has not been demonstrated.

Römer has made an extensive study of antipneumococcic serum in serpiginous ulcer of the cornea. In his first series of cases in which he used a polyvalent serum, he obtained somewhat better results than in a control series in which the serum was not used.

Later he supplemented the injections of serum by active immunization using for this purpose vaccines prepared from pneumococcus cultures. The suspension of killed pneumococci was given preferably first, followed in a few hours by the serum. Using this technique Römer was able to check the advance of the ulcer and obtain healing in 20 out of 24 cases. In 2 cases he had to resort to the galvano-cautery, and in the remaining 2 cases panophthalmitis developed. Some observers have been inclined to regard Römer's last series as made up of unusually favorable cases, and claim that if the infections had been of average virulence, his results would have been no better than those following ordinary symptomatic treatment. Römer has devised a method of injecting mice with progressive dilutions of the cultures obtained from each case, and ascertaining the minimum fatal dose of each strain. In this way the virulence of each infection being known, cases of equal virulence with and without active and passive immunization can be compared more accurately than by the clinical signs alone. Römer maintains that in his series, comparing cases of equal virulence as determined by animal inoculations, more rapid and satisfactory results were obtained with than without the serum.

Deutschmann's yeast serum. In 1907 Deutschmann published the results of his researches on serum derived from animals that had been fed on yeast cells. He claimed that although the serum contained neither demonstrable antitoxic, nor bactericidal properties, it had a distinct restraining and curative influence on pus infections and even infections by the tubercle bacillus. He recommended the serum in the treatment of corneal ulceration, parenchymatous keratitis, plastic iritis, and for wounds about the eye. v. Hippel has recently published a series of cases including plastic iritis and serpiginous ulcer in which he gives considerable credit to the serum. The action of Deutschmann's serum is not understood. It has been thought by some to act as a direct stimulant to phagocytosis. In this connection it may be noted that several of the specific sera, such as diphtheria antitoxin, tetanus antitoxin, etc., have been employed in diseases other than those for which they were intended, with reported benefit. Normal horse serum has also been used in the treatment of various pus infections. The unprejudiced observer must remain somewhat skeptical as to the value of a serum in cases of this character, where the claim for its good results is based only on empirical grounds.

Immune sera have been employed in either the prophylaxis or cure of a number of other diseases of known bacterial origin. Antiplague and anticholera sera have been used extensively in the Orient. Chantemesse also advocates the use of antityphoid serum in typhoid

fever and claims that it materially mitigates the severity of the disease.

Maragliano's serum. Maragliano has immunized animals (horse, cow) against tuberculosis, and finds that the resulting immune serum possesses bactericidal, antitoxic, and agglutinating properties for the tubercle bacillus. His statistics as to the clinical value of the serum, while not conclusive, seem to show somewhat more favorable results in cases in which the serum was used than in those in which the treatment was hygienic only. In some of his cases, Maragliano combined passive and active immunization, using for the latter gradually increasing doses of an extract of tubercle bacilli.

Marmorek's serum. Marmorek, by the immunization of horses with the toxins from young cultures of the tubercle bacillus has produced an antitoxic serum. The results obtained with this serum are not uniformly favorable, although in a number of instances including cases of tuberculosis of the larynx and virulent tuberculosis of the conjunctiva and cornea cures are reported following its exclusive use.

Reference must here be made also to certain preparations for the treatment of exophthalmic goitre. Beebe has injected animals with thyroid gland and obtained an anti-serum with which good results have been apparently obtained in some cases. Thus far, however, the serum has not accomplished all that was hoped for it. A preparation from the milk of thyroidectomized goats has also been used with benefit in some instances.

Bacterial therapy and active immunity. Early in the eighteenth century, following the observation that one attack of smallpox protected the individual against subsequent attacks, the inoculation of healthy persons with the virus from a mild case of smallpox was extensively practised, and after the discovery by Jenner of the protective power of successful inoculation with virus from cowpox, vaccination against smallpox became world-wide. Soon after the discovery of the bacterial etiology of anthrax, Pasteur, having observed that one attack of anthrax protected sheep or cattle against subsequent infection, devised the method of protective immunization of healthy animals by the injection of attenuated cultures of anthrax bacilli. A few years later he proposed the treatment of rabies by the injection of attenuated virus contained in the dried spinal cords of infected rabbits.

Thus gradually the idea of the prophylactic production of active immunity to disease gained ground, and it was only a step further, to the application of the method to cases in which infection was already present. We have seen that the injection of bacteria into the animal body gives rise to the production in the serum of certain substances

that have a definite destructive or inhibiting effect on the bacteria, and that these substances are within certain limits specific for each bacterium. Metchnikoff held that the essential factor in immunity was the phagocytic cell. Later Denys showed that if leucocytes are washed free from serum, they are no longer able to ingest bacteria. If, however, the bacteria are treated with serum, and then mixed with the washed leucocytes, they are at once taken up. This sensitizing substance, which prepares the bacteria for phagocytosis is called *opsonin*. See p. 9056, Vol. XII of this *Encyclopedia*.

From a study of opsonins in their relation to infectious processes, Wright developed the idea that they play an important part in the production of immunity in infections. He showed that in cases of infection by the tubercle bacillus for example, the injection of small quantities of tuberculin, containing the bacilli and their products, was followed by certain characteristic fluctuations in the amount of opsonin, and proposed therefore to use the opsonic power of the blood as a guide to the therapeutic injection of the bacterial products.

The *opsonic index* is determined by comparing the amount of phagocytosis occurring in suspensions of leucocytes, bacteria, and nor- to which has been added in place of the normal serum, the immune mal serum with that taking place in a similarly prepared suspension serum to be tested. See p. 9054, Vol. XII of this *Encyclopedia*.

The application of bacterial therapy in disease. We have already seen that high degres of bacterial immunity may be produced in otherwise susceptible animals by repeated injections of dead or attenuated bacteria. In man, this observation has been put to practical use in the prophylactic injections of vaccine prepared from the organisms of cholera, bubonic plague, and typhoid fever. In regions where these diseases are endemic, the incidence of the diseases in those who receive the injections is much less than in other untreated individuals under like conditions of hygiene and exposure.

Bacterial therapy as developed up to the present time in the cure of diseases is of value chiefly in chronic localized infections such as staphylococcus infections of the skin, tuberculosis and other infections of bones and joints, sinuses, etc. In these there is but little absorption of bacterial products, and consequently there is relatively slight reaction to the infection on the part of the body. The injection of killed cultures of bacteria appears to be a rational means of increasing this reaction and augmenting active immunity with a resulting acceleration in healing of the lesion.

Tuberculin immunization. Ever since the introduction of tuberculin by Koch, it has been used therapeutically in the various forms

of tuberculosis. In the early years, enormous doses, 50 mg. and more, were used, often with disastrous results. These cases caused a wide-spread opposition to tuberculin, and it is only comparatively recently that it has again come into general use. Now, however, we employ minimal doses, .001 mg. at the outset, increasing the dose later as the condition of the patient warrants. Several forms of tuberculin are employed for immunizing purposes. The new tuberculin, T. R., may be taken as a general type. It contains the residue of bacilli obtained by centrifugalization of an aqueous suspension of bacilli which have previously been dried and ground to a fine powder. This bacillary residue, from which much of the soluble toxic portion has been removed, is suspended in glyerin and water, so that 1 c.c. of the tuberculin (T. R.) contains .001 gm. of bacilli. The tuberculin is diluted with salt solution, or with an aqueous solution of glycerin shortly before use. Dilutions older than 2 or 3 weeks should not be used. Beginning with a dose of .001 mg., the injections are given at intervals of 2 or 3 days to a week. Some prefer to keep the dose at .001 mg. for some time. Others give gradually increasing doses ranging up to 1 mg. v. Hippel has reported cures in 23 cases of tuberculous iritis, and 3 cases of tuberculous conjunctivitis in which he used gradually increasing doses of T. R. beginning with .002 mg., and increasing to 1 mg. By this method favorable results have been obtained in tuberculous affections of the lids and conjunctiva, in keratitis, iritis, scleritis, choroiditis and retinitis of tuberculous origin by Reunert, Dorschlag, Wolfrum, Ziegler, Rohmer, Kraemer, and others.

Trudeau who made a careful study covering a long period of years of tuberculin immunization in pulmonary tuberculosis suggests certain principles by which the dosage and interval of injections can be gauged by the clinical symptoms. Clinical reactions, either febrile, local at the site of the lesion, or at the site of injection, or constitutional symptoms as malaise, anorexia, nausea, languor, sleeplessness, wandering pains and loss of weight are to be avoided. To this end the initial dose is very small and is increased gradually; should a reaction occur treatment is at once suspended until all symptoms have subsided and then resumed with the smaller gradually increasing doses. Denys who employs old tuberculin prepares 8 solutions. No. 1 contains .0001 mg. per cubic centimeter; No. 2 contains .001 mg.; No. 3, .01 mg.; No. 4, .1 mg.; No. 5, 1 mg.; No. 6, 10 mg.; No, 7, 100 mg.; No. 8, 1 cc. or pure tuberculin (liquid measure). Solution No. 1 is used in febrile cases only. In non-febrile cases, beginning with .1 c.c. of No. 2 the dose is increased by .1 c.c. given at intervals of 4 or 5 days until 1 c.c. is reached; then .1 c.c. of No. 3 is given, in-

creased at each dose by .1 c.c., and so on. The period of immunization extends over a number of months, during which in favorable cases the condition of the patient progressively improves. Other forms of tuberculin such as T. R. may be used in the same way, bearing in mind that in the old tuberculin the dilution is calculated on the basis of liquid measure, while in T. R., 1 c.c. of the tuberculin contains 1 mg. of dried bacilli.

The final word as to the value of tuberculin immunization cannot yet be spoken. Many competent observers feel that it is of distinct value in combination with other hygienic and tonic treatment. Trudeau found from a study of the post-discharge mortality of the Saranac Sanitarium covering a period of 15 years, that from 18 to 25 per cent. more of treated than of untreated cases were living at the time the report was written. On the other hand, certain workers, including Meissen in Germany, deny that tuberculin has any curative value. See **Tuberculin.**

Spengler holds that the toxins of the human and bovine tubercle bacilli are more or less mutually antagonistic, and in cases infected with one form, he employs a vaccine prepared from the other, with reported good results.

Active immunization in staphylococcus, streptococcus and other infections. The chronic pus infections of the skin, such as acne and furunculosis offer one of the best fields for the demonstration of the value of bacterial therapy. Certain of these cases, intractable to other methods of treatment have yielded to injections of killed cultures of the associated organisms. In some cases good results are obtained with stock vaccines, but it is usually found of advantage to prepare the vaccine from the autogenous organism. Different strains of staphylococci even though resembling each other in cultural characteristics may differ widely in toxicity and in their power of producing immunizing responses in a given individual and it is hence desirable to use for immunization a culture obtained from the lesion under treatment. Two or more organisms may be associated in a lesion, such as a sinus, and here we may immunize against one organism, and then the other, causing each to disappear in turn. Thus favorable results are reported in chronic suppurations of the accessory sinuses of the frontal and ethmoid bones.

Grey-Edwards found staphylococcic vaccine of value in 3 cases of hypopyon ulcer, and Maddox has reported good results from vaccine in a staphylococcus infection after cataract operation.

Immunization in pneumococcus infections [of the eye] has not been attended with any lasting benefit. Römer has suggested the combi-

nation of active immunization with passive serum immunization in serpiginous ulcer, but no conclusive data are at hand as to the value of the method.

In ulcerative endocarditis of staphylococcus, streptococcus and pneumococcus origin, injections of vaccines prepared from the autogenous organisms have so far not been successful in curing the disease. One case is reported by Wright in which the injections of vaccines was followed by recovery, but there is some question as to whether the symptoms were not due to sepsis, without active ulceration of the heart valves. There seems to be no doubt, however, that a temporary period of clinical improvement follows the injections in some instances, so that we are justified in adopting the treatment in this class of cases, so hopeless under other therapy.

In chronic gonococcus infections, gonococcus vaccines have apparently been of value in hastening the healing of arthritis and other metastatic lesions. In gonococcus infections of the mucous membranes, vaccines have usually been of little value, although Allen reports successful cases in conjunctivitis in adults.

Serum reactions in diagnosis. We have already seen that immune sera contain a number of antibodies such as the agglutinins in typhoid which may be utilized in the diagnosis of otherwise obscure infections. The work of Wright on opsonins opens another somewhat parallel road to diagnosis. In normal individuals the opsonic index for the tubercle bacillus usually varies within certain narrow limits (.8-12). If the opsonic curve is abnormally low (i. e., phagocytosis is less in the patient's serum mixture than in the normal pool serum mixture which is regarded as unity), Wright claims that tuberculous infection is present. Likewise, high tuberculo-opsonic indices or curves showing marked high and low fluctuations from day to day are indicative of tuberculosis. Following massage of an affected part, or after exercise, etc., the appearance of a marked rise or fall in a previously normal index is also regarded as further evidence of infection. The method has been applied in the same way to infections due to the staphylococcus, streptococcus, gonococcus, etc. The diagnosis of a joint lesion may lie between tuberculous and gonococcal arthritis. A normal tuberculo-opsonic index and a low or fluctuating gonococco-opsonic index indicates the gonococcal origin of the lesion.

In the hands of carefully trained workers, the method undoubtedly furnishes valuable corroborative evidence in diagnosis. Wright and others have reported many instances in which the diagnostic value of opsonic determinations was demonstrated by the subsequent course of the cases. It is well, however, to reserve final opinion until

further work has determined the limitations as well as the possibilities of the procedure. See **Bordet-Gengou phenomenon,** p. 1249, Vol. II of this *Encyclopedia;* as well as **Wassermann test; Koch's tuberculin reaction** (p. 6864, Vol. IX); **v. Pirquet's cutaneous tuberculin reaction** (p. 10228, Vol. XIII); **Calmette's ophthalmo-tuberculin reaction** (p. 1361, Vol. II); **Moro's reaction** (p. 7867, Vol. X); and the **Ophthalmo-typhoid reaction** (p. 9051, Vol. XII).

Irons believes that as our knowledge of the relations of foreign proteids in the animal body increases, it becomes more evident that we are only beginning to learn the possibilities in serum and bacterial diagnosis.

Much light has been thrown on the reactions of bacterial proteids by the extensive researches of Otto, Rosenau and Anderson, Gay and Southard, and others on the phenomenon of hypersusceptibility or anaphylaxis observed in animals following the injection of foreign proteids. If a small amount of horse serum for example is injected into guinea pigs, and then after a period of 10 days or more a second injection is given, the animals exhibit severe nervous and respiratory symptoms, and frequently die within a few minutes. If, however, the second injection is given within a few hours of the first, no symptoms appear. Vaughan has observed analogous phenomena following the injections of small quantities of bacterial proteids.

R. Kraus has published a series of experiments in which he was able to show that a condition of hypersusceptibility to bacterial proteids can be produced in guinea pigs by the injection of emulsions of the dead organisms of the dysentery bacillus, staphylococcus, and even of some of the non-pathogenic bacteria, so that subsequent injections of the corresponding organisms made after the lapse of 10 to 20 days, caused severe symptoms and death within a few minutes, while control animals receiving the same dose were unaffected. These observations are very suggestive as affording a possible explanation of the various phenomena of the tuberculin test; particularly those of the ocular and cutaneous reactions. In man, the work along this line has been confined chiefly to tuberculosis. See, also, **Serobacterin.**

Serotherapy, Darier (*Clinique Ophtalm.*, Oct., 1906) states, has given such marvelous results in ocular diphtheria, that one is encouraged to try it in the treatment of infectious ulcers of the cornea. The physiologic processes of the organism show us the rôle played by cells and fluids in resisting noxious matter of all kinds. Ehrlich and Roemer have proved experimentally, in their efforts of immunization against jequiritol, the power of these cells and fluids. Lastly, Roemer has sought to apply to the treatment of infectious corneal ulcers a

serum therapy which, in his hands, has already given results which are very encouraging. We know that serpiginous ulcer of the cornea or simple ulcer with hypopion to be ocular lesions of great gravity. Roemer gives us hope that an infectious ulcer of the cornea, if taken in time, will immediately be arrested by one injection of antipneumococcus serum—a treatment that is absolutely inoffensive and painless.

From the researches of Uhthoff and of Axenfeld we know that the infectious corneal ulcer has for its cause the pneumococcus of Fraenkel-Weichselbaum, and that it is found not only in the conjunctival sac, but also in the pharynx and nasal fossa. An antipneumococcus serum has been prepared by Pane in Italy, and the brothers Klemperer have brought about a number of pneumococcus immunizations; but it is not known whether this immunity results from a toxic effect or from an increased resistance of the cells or from the power of a specific substance which attacks the bacterial vitality. Darier believes it definitely established, since the research of Roemer, that the pneumococcus immunity is produced by antibodies which have a specific bacteriolytic action.

Darier tried the antidiphtheritic serum of Roux in a case of grave corneal ulcer consecutive to purulent ophthalmia. The cure was rapid and complete, so much so that Darier's pupil, Dalnoy, tried the same remedy serum in two similar cases, with a cure rapidly following.

The author also details a case of a large corneal ulcer with hypopion, the result of trauma, and, after various local antiseptics, galvanocautery applications, etc., without success, 10 c. c. of the Roux serum was injected in the patient's thigh with marked amelioration on the following day, when a second of 10 c. c. was given. Cicatrization was complete in fifteen days. Darier has had in several instances the same result in similar cases from this serum. See **Dorrell's syringe**, p. 4068, Vol. VI of this *Encyclopedia*.

George Mackay (*Oph. Review*, p. 196, June, 1908) reports a case (woman) of *phlyctenular keratitis and pustular episcleritis* treated by staphylococci injections. A small pustule was found on the conjunctiva near the inner and lower border of the cornea. This gradually improved under ordinary treatment, and one month later the vision in the right eye was 6/9 with correction, while that of the left was 6/24 pt. The patient remained well for three years, but in March, 1901, a small patch of conjunctival injection appeared at the outer side of the right eye, near the limbus, with some haziness of the adjacent cornea. This cleared up with the same treatment as before, but from this time there were constant relapses in one part after another, during the next six years, the longest being twelve months. Finally,

these phlyctenular elevations developed into larger yellowish nodules with some ulceration of the surface. Tubercle was then strongly suspected, and the opsonic index estimated, which, for tubercle, was found to be 0.74 and for staphylococcus aureus 1.24. A smear taken from the conjunctival sac revealed many polymorphonuclear leucocytes, no tubercle bacilli, but some staphylococci. Although, on the whole, the indications were not in favor of tubercle, an injection was given, but this being followed by a positive instead of a negative phase, the idea of the affection being of a tubercular nature was definitely rejected. The treatment next adopted was the injection of 1/500 milligram of dried staphylococci dissolved in 1 c.c. of distilled water, which was followed by a negative phase, but in 24 hours the opsonic index had risen to 1.86. After about 7 injections the nodules had completely disappeared, and there had been no recurrence until January 24th, 1908, when it took a much milder form, being merely of the nature of a slight congestion at the upper and outer part of the limbus. It was, however, thought advisable to give an injection occasionally as a prophylactic; and Mackay considered it necessary to continue the treatment periodically, even after all signs of inflammatory reaction had disappeared.

In opening the general discussion of this subject at the British Medical Association, Axenfeld (*Oph. Year-Book*, p. 44, 1909) pointed out that diphtheria antitoxin might fail to influence corneal infection because such infection was due to other pyogenic bacteria. Jequiritol serum prevents the over-violent action of jequiritol. Antipneumococcic serum is not sufficiently certain in its action to supplant surgical treatment. Streptococcic serum or vaccine may be used in streptococcus diphtheria of the conjunctiva. The serum treatment for gonorrhea is more likely to prove effective in metastatic affections than in purulent conjunctivitis. The polyvalent or non-specific sera, Axenfeld thinks, do not hold out anything like so good a prospect of success as the specific sera. He insisted on the importance of a high standard of experimental work to check or confirm clinical experience. Fuchs agreed as to the importance of experimental evidence. Hay and Hern coincided in the estimate of polyvalent sera. Harman thought that, so far as the eye is concerned, serum therapy had not established itself. Ritchie spoke of the superiority of bacterial suspension vaccines.

As the result of one hundred experiments on rabbits, including infections of the vitreous, anterior chamber and cornea, Hoppe reported that the value of Deutschmann's serum and diphtheria serum for eye infections in general, had not been demonstrated. In discussing

Hoppe's paper Deutschmann defended his serum, and quoted Meisser as crediting it with stimulation of the phagocytes. Römer said that the phagocytic index had, in many cases, nothing to do with cure. The body forms a specific serum to oppose the infection. Schmidt-Rimpler had treated four cases of serpent ulcer of moderate severity with Deutschmann's serum, with loss of both eyes. V. Hippel had good clinical results with this serum, especially in five cases of severe plastic iritis.

Römer pointed out with regard to pneumococcus serum and its use for serpent ulcer, that some pneumococcus infections heal spontaneously, while others are of such enormous virulence that any therapy must be thwarted. Between these lies the field for serum-therapy, which may help to check the infection. Napp reported of the extensive trials made with Deutschmann's serum at Berlin; that while harmless, except in producing a slight eruption, it had not exerted any therapeutic influence in the diseases for which it was employed. Deutschmann had collected a number of clinical reports favorable to his "Heil-serum."

Schwalbach was pleased with the result obtained in a case of phlegmon of the orbit. Zimmermann reported eleven cases indicating that it had some value in wounds of the eye and serpent ulcer. Antonelli said that for severe injuries of the eyeball, the use of nonspecific serum (antidiphtheritic) is easy and inoffensive, and from its use we have "all to hope and nothing to fear." Teulieres had found it a useful adjuvant to usual methods. Bailliart reported four cases of iridocyclitis and hypopion keratitis in which the result of the treatment with antidiphtheritic serum was strikingly favorable. Müller and Peiser discussed the treatment of suppuration from the standpoint of the antiferments. Sardou suggested injections of extract of the eyeball to relieve ocular fatigue. Berghausen reviewed the recent advances in eye work through bacterio-therapy.

Later the *Ophthalmic Year-Book*, p. 52, 1909, abstracts additional papers on this subject. Rissling has studied the fluctuations in osmotic tension of the sera of normal animals, the horse, calf, sheep and pig, and the similar fluctuations of the intraocular fluids. The existence and extent of these variations in 15 to 25 animals of each species he has set forth in elaborate tables. In each species the intraocular fluid showed the same tension as the serum in the largest number of cases, but in other individuals varied both above and below. Gatti finds in the cornea and lens of the eye slight traces of hemolytic power. Fleischer had positive results from cerebrospinal fluid.

Filatow injected into the vitreous of normal animals blood serum

from other normal animals of the same and of different species. In animals of the same species, and sometimes of other allied species, no reaction was produced by the injection, but where the source of the serum was very different from the animal into which it was injected, an iridocyclitis was set up. Injections into the vitreous of hetero-serum, rendered hemolytic by previous injections of blood corpuscles, always caused a severe irido-choroiditis with fibro-cellular exudate, but no reaction was provoked by injection of such sera into the general circulation.

Teulieres (*Prac. Med. Series, Eye,* p. 251, 1909) had used *antidiphtheritic serum* in eye affections of an infective nature, especially in hypopion keratitis. He found that it was a curative agent; often, however, only a useful adjuvant to the usual methods employed in these conditions. It should be used subcutaneously and as soon after infection as possible. It may be employed as a prophylactic measure. His results show that it ameliorates the pain, checks the progress of the infection and favors the absorption of the infiltrate and exudate and the formation of newformed tissue.

Gilbert (*Oph. Year-Book,* p. 119, 1909) advises the use of beef serum for irrigation in blennorrhœa neonatorum, instead of the ordinary antiseptic solutions. He believes the germs are not killed, but are converted from a parasitic to a saprophytic existence, and the disease made less severe. The soil is thus prepared for the subsequent treatment with silver (1 per cent. silver nitrate), and quicker cures are secured by this combined method.

Zimmerman (*Ophthal. Klinik,* Nov. 5, 1908) has employed Behring's diphtheria serum in a series of cases of inflammatory and traumatic conditions of the eye. When the initial dose is 1500 units he finds that in many cases only one injection is required to bring about a cure. If 1000 units were first used the result was less favorable and a repetition of the dose did not have nearly the effect of a large initial dose. If early beneficial effect is not noted no further improvement will result from repeated injections. In no instance was any complication noted; no skin exanthemata nor any subjective disturbance. He says that while there were some cases in which a combined local and serum therapy was employed he is convinced that eyes were thus saved that would have been lost notwithstanding energetic surgical treatment alone. The list contains cases of infected corneal ulcer, postoperative infection and severe iridocyclitis, traumatic cataract, gonorrheal iritis, orbital cellulitis from infection. Four unsuccessful cases were an acute postoperative infection, two large septic ulcers of the cornea and a purulent dacryocystitis.

The pathogenic agent of rheumatism is, in the opinion of Deschamps (*La Clinique Ophtalmol.*, May 10th, 1910; abstract, *Oph. Review*, p. 303, Oct., 1910) the bacillus of Achalme, which resembles anthrax bacillus.

He gives his experience with the Rosenthal-Berliox anti-rheumatic serum. He appears to have taken great pains to select only true cases of rheumatic iritis, but on carefully reading these one is inclined to think they may have been due to gonorrheal infection. However, the cases selected were severe and aggravated types of iritis with much albuminous exudation into the anterior chamber, which did not yield to the ordinary treatment of salicylates, mercury, atropin, etc. The patients were subsequently subjected to injections of the anti-rheumatic serum (20 cubic centimeter doses), two and even three injections being given at short intervals with startling immediate results. That is, the exudation in the anterior chamber disappeared like magic. It would appear, however, that this relief was not maintained for any length of time, as after ten days there were relapses, though mild, in each case.

The author's conclusions were that these injections were not altogether free from certain drawbacks, such as serum rashes, and in one instance they were followed by alarming symptoms. It would seem therefore that this serum treatment is to be used as an adjuvant to the ordinary anti-rheumatic one, and when the injections are repeated, the patient must be carefully watched. M. Deschamps also recommends chloride of calcium in 2 gramme doses daily, as a preliminary to the serum injections.

George S. Derby (*Ophthalmology*, Jan., 1911) gives an exhaustive review of vaccine and serum therapy in ocular tuberculosis. He believes that beneficial results may be obtained with all the standard preparations. On general principles, however, the filtrates or solutions, such as Koch's old tuberculin T. O., and those of Denys, B. F., and Beraneck, T. B. K., are safer for the beginner, more uniform in their dosage, and less likely to cause noticeable reaction than are the emulsions or vaccines T. R. and B. E. Theoretically, B. F. and T. B. K. are better than preparations in which heat is used to manufacture. Thus far there is not enough evidence available to decide the relative merits of human and bovine extracts.

Tuberculin solutions should be reasonably fresh, and should be renewed from the stock solutions not less than once every two or three weeks, and it is advisable to make very high dilutions weekly. Even the 0.5 per cent. phenol solution used in making the dilutions is sufficient to cause deterioration in the tuberculin after a time. The emul-

sions should always be thoroughly shaken before measuring off the dose. Directions for making the dilutions come with all tuberculins. Where a considerable number of patients are to be treated, it is desirable and convenient to make up a number of dilutions of varying strength. Dilutions of 1:10 are convenient and in general use.

Syringe. A glass syringe of 1 c. c. capacity is preferable, on account of ease in sterilization and measurement.

Injections are best given in the back, below the scapula, alternating the side on each successive occasion. For convenience, however, the upper outer aspect of the arm may be used. The skin is cleansed with ether or alcohol, and the puncture may be closed with collodion if desired.

Dosage. Authorities are divided on what tuberculin accomplishes. If the theory of specific bacterial immunity be accepted, then general and focal reactions hold a place in the treatment. They hold no palce, however, in Wright's method, for he regards fever reaction as a manifestation of a negative phase, and simply tried to measure the amount of specific immunity produced by opsonic index determinations.

The adherents of the toxic immunity theory also try to avoid reactions, regarding them as evidence of intolerance, they produce no specific immunity, and although when mild they do no harm, in their severer forms they injure the patient's general condition and make the disease focus more active.

Bandelier and Roepke state: "If a mental picture is to be made of the curative action of tuberculin in the light of present-day knowledge, it must be based on a consideration of the two specific factors of its action—the production of toxic immunity and the local hyperemia."

Certain observers use large doses at infrequent intervals, intending thereby to produce a marked local reaction.

This practice, it seems to the writer, should be discouraged, as it is pretty definitely established that such heroic measures may produce harmful results not only to the eye itself, but also to the whole organism, for it must be remembered that with this method of injection we have no way of controlling the severity of the reactions. On the other hand, Wright and his school maintain that the administration of very minute doses, 1/100,000 to 1/10,000 mg. of new tuberculin, repeated at long intervals and increased only to a slight extent under the control of opsonic index estimations, is the proper method of administration.

The choice of the great majority lies between the two extremes. The initial dose should be small—T. O., 1/500 to 1/100 mg.; B. E. and T. R., 1/1000 to 1/500 mg.; B. F., 1/10,000 to 1/1000. (The writer

prefers the smaller doses in each case.) It should be increased slowly and with great care, avoiding, as far as possible, all signs of reaction, both general and local. When increasing from one solution to the next higher, the step should be gradual, e. g., 9/10,000, 1/1000, 1.5/1000, 3/1000, etc. It is not unlikely that slight local reactions occur with each injection, but these, when slight, are probably beneficial, and every effort should be made to keep them at a minimum.

Frequency. von Hippel regarded two days as the proper period between injections; later, Wright and his school advised much longer periods—eight or nine days, even to three or four weeks (Allen). Again, a middle course seems desirable, and four to five days may be taken as the average time between injections. It is most important, however, to have no settled rule, but to treat each case on its own merits. The rate of increase and frequency of dosage may be controlled by careful observation of the temperature, which is best taken four times daily, by the pulse, by careful attention to the general condition of the patient, loss of appetite, malaise, etc., and by careful observation of the eye itself when that is possible. A local reaction at the point of injection may also give evidence of a beginning intolerance. After a rise of temperature of more than .5° F., or any other toxic symptoms, the previous dose should be repeated until it no longer causes disturbance. If the toxic symptoms are pronounced, the interval should be lengthened or the next weaker dose given, or both. It is best not to inject during the first few days of the menstrual period. The treatment of many patients may be carried through without the signs of a reaction, but in most instances at some period the symptoms of intollerance appear, and we should be on the lookout for them. Marked reactions may lead to hypersusceptibility, and then even if the dose be considerably reduced, the patient continues to react. In such cases Trudeau advised discontinuing injections for from ten days to two weeks, and then beginning again with a far weaker dose, and increasing very gradually.

The majority of cases of ocular tuberculosis may be treated as outpatients, coming to the hospital at stated intervals for observation and injection. It is indispensable to have them keep a careful record of their temperature, pulse, and general symptoms in a book designed for the purpose. They should be controlled as closely as possible by having a social worker or nurse visit them in their homes occasionally, and see that they carry out the directions received. It should be strongly emphasized that general tubercular hygiene forms the most important part of the treatment of these cases, and that if we expect to get good results from injections, we must get the system into such

condition that tuberculin can be utilized to the best advantage.

Derby records 30 cases of ocular tuberculosis treated by tuberculin; 15 of sclerokeratitis; 9 of interstitial keratitis, and 6 of kerato-iritis.

On the whole the results are favorable, although in a number of cases it is by no means certain that a cure would have taken place as speedily without the tuberculin treatment.

Coley's fluid or Coley's toxins. See p. 2322, Vol. IV of this *Encyclopedia.*

Cytogenic sera. Cytosera. Rogers (*Oph. Review,* p. 118, April, 1911) reports satisfactory results from the use of these sera in a large number of cases in thyroid disease.

The cytoserum of carcinoma has not been used yet in carcinoma of the eye.

Coma serum. Roemer (*Oph. Review,* p. 125, April, 1914) has described the investigations which he conducted with Kochmann, into the action of the coma-serum. He found that the serum was capable in healthy animals of lowering the intraocular tension: the substance contained in the serum which has this action seems to vary in concentration very considerably, and does not appear to depend upon osmotic activity for its efficiency. That serum which has been prepared from animals which have died comatose seems alone to be efficacious in diabetes, even when artificially induced. The two observers have given considerable attention to the question of the rise of tension induced when subconjunctival injections of salt solution are employed, but are unable to give any satisfactory explanation. Apparently subconjunctival injections of distilled water are capable of raising the tension; and when the tension is thus increased any local anesthetic is capable of reducing it again, though they do not all act with the same vigor. The observers found differences to exist in general anesthetics also, for while ether leaves the raised tension uninfluenced, in anesthesia by chloroform the tension sinks again, even when care in administration is directed to making certain that the general blood pressure has not fallen. When nitrite of amyl is administered the intraocular pressure may even remain high while the intravascular tension is lowered.

The important work of C. W. G. Bryan (*Brit. Med. Journ.,* March 16, 1912) has been abstracted in *Ophthalmology,* p. 564, July, 1912. The writer points out that the *treatment of eye diseases by serums and vaccines* differs from similar treatment of disease in any other part of the body, owing to the anatomical peculiarities of the blood and lymph supply. The cornea and vitreous have in the healthy

condition no blood vessels, and are feebly nourished in lymph; the lymph circulation of the intrinsic parts of the eyeball is, however, not free. Again, in those parts of the eye where there is a supply of blood vessels the distribution of the blood in these vessels is constantly varying owing to the unceasing movements of the eye as a whole, and of its various parts—the iris, ciliary body, etc. These movements are of importance when the eye is infected, as they cause the setting free of bacterial substances, toxins, etc., in the blood stream.

Active immunity can be acquired in two ways—either by auto-inoculation by bacterial substances set free in the blood stream from some focus of disease, or by the methods of hetero-inoculation—that is, by the absorption of vaccine, usually injected into the subcutaneous tissues. In disease of the eye, auto-inoculation is an unsatisfactory method of producing immunity, owing to the limited blood and lymph flow in the eye, and to the fact that the size of the area of infection, as compared with the body as a whole, is small, and therefore great disturbance of this small area would be necessary to produce any marked auto-inoculation. In using vaccines it is necessary as far as possible to prevent auto-inoculation by keeping the diseased part at rest, and this is a difficulty with which we have specially to contend in dealing with eye diseases.

The writer then goes on to explain the work of Wright and the opsonic index. With regard to dosage it is necessary to give larger doses of vaccines in diseases of the eye than in treating disease elsewhere, because the blood and lymph flow being limited, a less amount of opsonin will be brought in contact with the diseased area, and also the risk of toxic effect is less, as the area of infection is small.

Bryan takes up the subject of ocular tuberculosis in connection with which he states that the general opinion is that the use of old tuberculin is attended by unjustifiable risk, and it has been superseded by less dangerous preparations. He describes briefly some of these newer forms of tuberculin. He describes the two most important methods of dosage. 1. Wright's, commencing with a small dose, 1/80,000 to 1/10,000 mg., gradually increasing the dose over a long period of treatment with about ten days' interval between each inoculation, the dosage being regulated by estimates of the opsonic index; and 2, Von Hippel's method of treatment with tuberculin T. R., commencing with an initial dose of 1/500 mg., repeating the inoculation on alternate days, increasing each time by 1/500 mg. until 1/50 mg. is reached; after this the dose is increased each time by 1/50 mg. up to 1/5 mg.; then, by 1/10 mg. until a dose of 1 mg. is reached. During the treatment the temperature should not rise above 100° F.;

if it does so, the previous dose, or a smaller one, is repeated until there is no rise in temperature after the inoculation.

He next discusses the various forms of ocular tuberculosis and gives a summary of the results which have been obtained in each, interspersing his remarks with histories of his own cases. The results in cases of extrinsic tuberculosis are shown to be very encouraging. Regarding internal tuberculosis of the eye, he says that we find that the results of treatment by vaccine are good, especially where the iris is the diseased tissue. The iris is favorable for treatment because it has a good blood supply. In tuberculosis of the fundus, where the blood and lymph supply are poor, treatment has to be prolonged, and is less certainly successful. It may be mentioned here that in disease of the iris it is necessary to use mydriatics to prevent the formation of synechiæ, and, the blood supply in this way being diminished, treatment rather tends to be prolonged, owing to the difficulty of getting sufficient opsonins into the diseased tissues.

The writer next takes up the consideration of diseases of the eye due to pyogenic organisms and states that it is advisable in these cases to use a specific vaccine, from cultures of the infecting organism obtained from the patients to be treated; this is generally unnecessary in staphylococcus infection in which a mixed stock vaccine, prepared from cultures of staphylococcus aureus citreus, and albus, is usually efficient. He describes the method of preparing vaccines.

The paper then deals with the vaccine treatment of the various regions which come within the province of eye surgery, dividing these into external and internal infections. Among the former group he discusses the results in affections of the lachrymal sac, blepharitis, chalazions, hordeola, various varieties of conjunctivitis including gonorrheal (ophthalmia and the systemic forms), chronic conjunctivitis and phlyctenulæ, and finally ulceration of the cornea; in many of these affections excellent results have been reported as a result of vaccine treatment. He states also, and recites histories to prove his assertions, that vaccine treatment is of great value in post-operative infections, the prognosis of which has been so bad in the past.

He takes up the question of the internal infections. Here the bacteriological diagnosis is difficult. However, in cases of iridocyclitis cultures have been made from the aqueous after paracentesis and the vaccines prepared from these have been used with excellent results.

F. Terrien (*Archives d' Ophthalm.*, February, p. 106, 1912) reports the cure of an unusual case of partial paralysis of both external recti in a child of 5½ years. Six weeks previously the child had a mild attack of pharyngeal diphtheria, which yielded readily to an injection

of antidiphtheritic serum. Six weeks later the voice became nasal, and nine days later the convergence and diplopia appeared. Forty ccm. of antidiphtheritic serum were injected under the skin of the abdomen. There was no reaction, and no results were seen for three days, when it was found that the paresis of the external recti had vanished during the night; the paresis of the soft palate disappeared three days later.

Serotherapy by way of the mouth is to some extent and in certain instances advocated by Darier (*Clinique Ophtalm.*, No. 3, March, 1912). He recalls the work of Spiess, of Frankfort, who saw good results from the introduction into the stomach of 25 cc. of antistreptococcic serum in infectious anginas, erysipelas, etc. No unpleasant reaction was ever observed. Voss also records that he has far fewer cases of mastoiditis to operate on since he has begun the early use of the serum by way of mouth. Darier advises a trial of this serum in iritis, corneal ulcers, and infections of the eye from trauma or operation. The injection of serum sometimes gives rise to grave and alarming consequences, which are absent in the oral exhibition, so that one would be justified in using it in this way whenever there is reason to suspect an infection, thus saving much valuable time lost in making a bacteriologic diagnosis. He uses a mixture containing 20 cc. of antidiphtheritic serum (this being the most easily obtained serum), 30 gr. of syrup, 150 of water. Of this a tablespoonful is given every hour.

G. L. Colombo (*La Clinica Oculistica*, p. 979, 1912; W. G. Souter's review in the *Oph. Review*, p. 264, Sept., 1913) discusses the use of antigonococci serum in specific cases of ophthalmia neonatorum. Up to the present the line of treatment in cases of gonorrheal conjunctivitis has been by way of antiseptics, acting chemically, since till now the beneficial results of vaccines and of sera which enhance the phagocytic action of the leucocytes have been almost entirely limited to gonorrhea of the urethra; for various reasons the conjunctival affection does not lend itself readily to the same mode of attack.

From the horse and certain other animals there can be prepared an anti-gonococcal serum containing the anti-bodies of the gonococcus.

Contrary to the experience of most others, Colombo has been fairly well pleased with the results of his treatment of ophthalmia neonatorum by means of anti-gonorrheal serum. He evidently, however, has not had the courage to depend on this alone, for he says that before dropping the serum into the conjunctival sac he irrigates the part thoroughly with 1/5000 corrosive sublimate and paints with nitrate of silver. After that several drops of the anti-gonococcic serum are instilled into the conjunctival sac; the process is repeated twice

a day, and the results Colombo finds to be highly gratifying. For example, the palpebral edema diminishes quickly, and the purulent discharge becomes muco-purulent and then mucous within one, two, or perhaps three days, and the quantity of it is much reduced; where the cornea has not been affected previously it is found to remain free from complications, and where it was already infiltrated and hazy, it regains its transparency and normal aspect. The period of infectivity is also reduced: in other words the period during which active gonococci are to be found in the conjunctival discharge.

It is no fair test of a remedy for gonorrheal conjunctivitis that it does not succeed in saving a cornea which is already ulcerated or densely infiltrated in consequence of the macerating influence of the pus and of its contained germs upon the tissues of the corneo-scleral region, and of the pressure resulting from the chemosis. The serum is no exception to the rule, and it will work no miracle where such a condition exists before it is applied; it will not restore life to necrosed tissue.

It is no easy task to decide in what manner the serum acts, more especially because gonorrhea is a disease so difficult to produce in the lower animals, towards which the gonococcus appears to have little virulence, so that one has to depend for the most part upon clinical investigation alone. Those observers who have employed the serum locally are of opinion that it may act directly upon the germs by agglutination, by bacteriolysis, or in some such way, but consider it more probable that its action is rather anti-toxic; some hold that it so influences the gonococcus that the antiseptic applications employed have their efficiency enhanced, and even that the germ is so altered in nature as to become a harmless visitant rather than, or instead of, a bitter enemy.

In regard to such a matter as this the conjunctiva is a region peculiarly well adapted for the study of the reaction of tissues to infection and to treatment, for one can so readily examine the aspect and the quantity of the purulent (or other) discharge, the action of the toxins upon the cornea, the numbers and morphological character of the organisms present, and so on. That being so, and even bearing in mind the great variation in the severity of gonorrheal infection of the conjunctiva and the fact also of its relative mildness in infants as contrasted with adults, Colombo is confident that in the treatment indicated in this paper we possess a very powerful means of combating this dreadful disease, of rapidly reducing the amount of pus, and changing its constitution from pus to mucus, and apparently of preventing almost completely the occurrence of corneal complications.

In regard to treatment there are three elements of importance. First, nitrate of silver is of unquestionable efficiency in bringing about improvement in the condition, and diminution alike of pus and of symptoms, but it does not altogether prevent the occurrence of any severe and grave corneal complications: as the improvement secured by nitrate of silver is not very rapid, there is considerable risk of the cornea becoming involved. In some of the cases in which the application of nitrate was carried on steadily and regularly but the use of anti-gonococcic serum was interrupted, it became plain that the nitrate alone was not capable of preventing the presence of large numbers of gonococci, which grew and multiplied with great activity in spite of the painting with that useful remedy.

The author makes reference to certain (eight) cases of Gilbert's in which he obtained a good result with normal ox serum applied every two hours, day and night, and with occasional use also of nitrate of silver. Here there must be question whether so frequent applications of serum do not act mechanically for the most part, clearing away toxins and their products, and preventing them from injuring the tissues; incessant bathing was a method of treatment of purulent ophthalmia suggested long ago. Gilbert suggests that there is something more to be taken into consideration, for the constant irrigation greatly increases the phagocytosis of the gonococci. Gilbert attributes a large amount of its action to the phagocytosis of the leucocytes which occur as a result of the application of a substance so rich in opsonins, but it may have a more directly anti-gonococcal influence. In a certain number of his cases Colombo observed that on cessation of most of the sera there was a fresh outbreak of the conjunctivitis: that fact does not suggest that the beneficial effect was all due to phagocytosis. The action is probably two-fold, upon the organisms and upon their toxins, whether these be elaborated by the germs or results from their breaking down; both theories have been put forward.

There is, however, no room for doubt that the serum attains its effects principally through direct action on the gonococcus. It is quite true, as numerous investigations have proved, that the gonococcus can grow and multiply even after contact with the serum, but for all that the serum may have an effect in reducing the activity and infectivity of the organism just as is the case with certain other bacteria, which may present all the normal features and yet lack vitality or virility. Is there any evidence to be obtained, then, of such effect upon the gonococcus? Sometimes in the midst of a clump of bacteria, such as is common in the discharge from a case of gonorrheal ophthalmia, one finds some which are more feebly tinted, altered looking, and now and

then swollen, but these changes are rarely to be seen and are not to be relied upon where so many factors may be at work.

The most probable explanation is that the serum reduces the pathogenic activity of the gonococcus: its biological activity is so altered that its injurious action on the tissues is almost annulled; it is not easy to see how else to explain the association of increased numbers of the organism with reduction in its toxicity; and the same phenomenon is seen from time to time in the urethra.

The organisms thus collected in immense numbers extracellularly probably fall victims to the agglutinating influence of the serum, but the gonococcus is an organism which varies greatly in different cases as to its resisting power.

The extensive and valuable studies of Stephen Mayou (*Annals of Ophthalmology*, October, 1912) are reviewed by R. Beatson Hird (*Oph. Review*, p. 269, Sept., 1913).

Mayou points out that the *action of sera and vaccines being so specific, it is most essential that the cause of the eye disease to be treated should be accurately diagnosed.* The cause may be arrived at by one of the following means: (a) The clinical changes set up by the organism may be characteristic and distinctive. (b) The organism may be found on microscopic examination of the secretion or in the intraocular fluids. (c) The histological appearances of the affected tissue may be so characteristic as to reveal its nature. (d) Biochemical examination of the changes produced in the blood-serum or fluid obtained from the anterior chamber. Precipitation, agglutination, Bordet reaction. (e) The reaction produced by the introduction into the bloodstream of small doses of the dead organism (vaccine) similar to that causing the lesion (anaphylaxis). This may be seen (1) locally at the site of the lesion; (2) in the blood, it may be gauged by the opsonic index or biochemical reaction; (3) or in the whole organism by the production of fever. (f) The local reaction of the tissues to vaccine (surface inoculation), due to anaphylaxis, e. g., von Pirquet, Moro, Calmette. (g) The inoculation of the diseased tissues into animals will reproduce the disease in a more typical form if the animal is susceptible.

Mayou then proceeds to discuss the preparation of sera and vaccines used for the treatment of ophthalmic diseases.

Sera act either by their antitoxic, bacteriolytic, or opsonic powers.

The serum of diphtheria and tetanus is in each case an antitoxic one. These two are well known and of considerable value.

This cannot be said of streptococcus serum probably for two reasons, viz., (1) it can rarely be given early enough, (2) there are so many different strains of the organism.

Many authorities have upheld the value of pneumococcus serum, Römer's being the best, not only for corneal ulceration but also as an immunizing agent in intra-ocular operations and in cases of orbital cellulitis due to that organism.

Vaccines are sterilized, standardized emulsions of micro-organisms, except in a few instances, such as hydrophobia, where the actual organism or its toxins are used.

The chief diseases of the eye in which Mayou has found vaccines of service are the following:

Affections of the eyelids. Styes, disease of the Meibomian glands, and multiple recurrent chalazion are usually due to staphylococcus and can be treated with vaccines to advantage.

Affections of the conjunctiva. Many of these conditions get well so readily by means of ordinary remedies that vaccine and other treatment is unnecessary. Diphtheritic conjunctivitis should be treated by means of the serum. In streptococcal infections "Menzer's streptococcus serum" made by Merck is the best. It is a polyvalent one made from 200 different strains of streptococcus. In gonococcal conjunctivitis Mayou agrees with others that a vaccine is of no real value. Tubercle of the conjunctiva and lupus benefit by the use of tuberculin. In trachoma he has used jequiritol (Merck). He has always used number 4 strength straightaway and has never required to use jequiritol serum.

Affections of the cornea. Corneal ulceration due to staphylococcus can be treated by vaccine beneficially, and when the pneumococcus is the causal agent Römer's serum may be of use. Keratitis profunda is due to toxins in the aqueous, syphilis, tubercle, and septic infections (especially staphylococcal) of the uveal tract being the common causes of this condition.

Affections of the sclera. Mayou thinks the balance of evidence is in favor of most of them being of tubercular origin and he quotes several cases which did well under tuberculin.

Affections of the uveal tract. Meningococcal serum may be tried in cases of suppurative uveitis due to the *diplococcus intracellularis meningitidis.* He treated one case of acute nonsuppurative uveitis by means of staphylococcal vaccine with success.

Gonorrheal rheumatic iritis is now treated with considerable success by means of a vaccine.

There are three chief causes of chronic uveitis, the tubercle bacillus, staphylococcus, and spirocheta pallida. The common sources of the staphylococcal infection being pyorrhea alveolaris, boils, and leucorrhea. The intestinal tract may also be a source of infection.

Chronic middle ear disease usually gives rise to a suppurative inflammation.

In making a clinical diagnosis the form of "K. P.," keratitis, iritis, etc., must be carefully gone into. In addition a bacteriological examination of the aqueous should be made, and such tests as the Wassermann and von Pirquet's should be carried out. Mayou gives a number of cases in tabular form.

Affections of the choroid. Choroiditis may be associated with lesions of the anterior portion of the uveal tract and will be due to the same causes. Solitary lesions may be due to either tubercle, sepsis, or syphilis. The septic infection is staphylococcal, as a rule from pyorrhea alveolaris, boils, etc.

Wound infection. The most frequent organism is the staphylococcus again. Mayou found it in five out of six cases, but other organisms such as the streptococcus, pneumococcus, and bacillus capsulatus also occur. Unfortunately in most instances accidental wounds which are infected usually terminate in panophthalmitis, and such acute affections are not remediable by sera or vaccines.

Operation wounds. Here again the staphylococcus is one of the chief offenders. It is particularly difficult to get rid of when associated with the Morax-Axenfeld bacillus. In these cases it is most desirable to produce an artificial immunity before operation by means of mixed vaccines.

After operation. Two clinical forms of wound infection are recognized: (1) Suppurative. It is obvious that in panophthalmitis it is useless to use immunizing agents to save the eye. If the orbit becomes infected, sera, such as streptococcal, pneumococcal, tetanus, etc., may be used, depending on the organism which is found on examination, with the hope of preventing general infection or the spread of the inflammation backwards to the meninges.

Wound infection after cataract operation is often due to staphylococcus albus and can be treated by means of a vaccine.

(2) Non-suppurative. To this group must belong sympathetic ophthalmia.

Chronic staphylococcal lesions of the skin by general blood infection may give rise to non-suppurative inflammation.

Mayou treated ten cases of cyclitis with "K. P." by means of vaccines, five of which cleared up after four inoculations at intervals of two weeks.

Darier (*Clinique Ophtalm.*, March, 1913) reviews the experience of others and gives his own in favor of the value of *autogenous vaccines* in certain eye diseases. He reports the effects of serum removed from

artificially formed blisters and injected subconjunctivally in various cases. Abscess of the cornea with hypopyon responded in three days, parenchymatous keratitis of tuberculous origin cleared up following this treatment. Cases of iritis, scrofulous keratitis, vernal conjunctivitis and sympathetic ophthalmia were all improved.

The writer finds, however, that antidiphtheritic serum has proven fully as efficacious, and believes that the subconjunctival injection is the effective agent. Serum is obtained in a more scientific manner by bleeding the patient, centrifugating and drawing off the fluid. The favorable action is attributed to the formation of a special vaccine, probably specific to the patient suffering, by overcoming the micro-organisms and combating their toxins.

Darier has had two disappointing cases, one a scelrosing keratitis and the other tuberculous interstitial keratitis.

He also calls attention to autoserum therapy by way of the buccal mucous membrane, in addition to subconjunctival injections.

Janson (*Oph. Year-Book*, p. 30, 1913) decries the enthusiasm of some French writers for the use of antidiphtheric serum in such non-diphtheric conditions as hypopyon ulcer and postoperative infection. The practice is opposed by the accumulating evidence of the strictly specific reaction of the tissues against poisons and foreign substances of every kind. Janson has experimentally compared the serologic reactions of normal rabbits and of rabbits previously treated with diphtheria antitoxin. For the agglutination experiments he employed bacillus typhosus and paratyphosus. For the rest of the experiments the staphylococcus and pneumococcus were used. As regards agglutination, complement fixation, and the opsonic index, there was no appreciable difference between the serum of the treated and that of the non-treated animals. The same negative results were obtained when the antitoxin was administered by mouth; and no beneficial results were obtained in the treatment of experimental infections of the anterior segment of the eye. In reply to Janson's criticisms Darier complains that Janson's clinical experiments were based upon the too exclusive use of the serum to the neglect of local measures. He himself recommends the administration by mouth in every twenty-four hours of at least 10 c.c. of serum containing 2,500 antitoxin units; and at the same time the instillation of strong doses of dionin, together with the use, according to the indications of the individual case, of subconjunctival injections, some form of cautery, conjunctival autoplasty, and paracentesis or transfixion of the cornea.

Before operation for cataract, at least in such cases as have a conjunctiva rich in bacteria, Axenfeld and Arisawa are in the habit of

giving repeated preliminary injections of autogenous vaccines prepared from the flora of the patient's conjunctival sac. With such a precaution, they obtained smooth primary healing in a case of madarosis after severe blepharitis, in one of pronounced ectropion, and in one of chronic suppurative discharge associated with desquamation after a plastic lid operation for carcinoma.

J. Dairdovics (*Oph. Review,* p. 64, Feb., 1914) reports the results obtained by the application of the Wassermann test in about 150 cases of eye disease. The general results appear to be that this reaction has a greater diagnostic value in eye disease than in that of other organs; in that in syphilitic eye disease a positive reaction is nearly always obtained. A negative reaction indicates with great probability if not with certainty that the eye lesion is not syphilitic, much more than appears to be the case from statistics of disease of other parts. It is noteworthy that a comparatively small percentage of cases of choroiditis gave a positive Wassermann reaction. In the author's opinion, this may indicate that tubercle is a more common cause of choroiditis than is commonly believed.

Jacovides (*Clinique Ophtalm.,* Sept., 1914) *has treated* by *autosera* 25 hypopyon-ulcers of the cornea, 15 cases of infective keratitis of various kinds, 2 cases of acute iridocyclitis, 1 endogenous infection following a cataract operation, 2 corneal infections after traumatism with foreign bodies, and 1 abscess of the cornea following an infected chemical burn. The method followed is essentially that of Rohmer, of Nancy, in which a blister of considerable size is formed (by Rohmer on the arm, by Jacovides on the thigh), the fluid from the blister being then injected subconjunctivally. The amount of fluid so obtained varies from a maximum of 3 cc. to a minimum of ½ cc. The writer concludes that the serum, injected under the conjunctiva, acts something like a foreign body and causes a local inflammation of the conjunctiva, the lymphatic elements of which, combined with the polynuclears of the serum, bring about an intense phagocytosis, by means of which the micro-organisms of the ulcer or abscess of the cornea are destroyed.

The *serum of Nicolle and Blaizot* (*Académie des Sciences,* Oct. 6, 1913) was presented to the profession in October, 1913, for the cure of all gonococcal infections. According to the discoverers this vaccine contains a mixture of nine parts of synococci to one part of gonococci. According to Nicolle and Blaizot, "synococci" are organisms very closely allied to the gonococci, and always associated therewith. Their most important characteristic is that they take up Gram. With this vaccine, Cuénod and Penel, of Tunis, treated twenty-six cases of

gonococcal conjunctivitis, and came to the conclusion that it was a sure remedy in this affection. Offret, after treating thirty-two cases, reached a similar conclusion.

Roche (*Clinique Ophtalm.*, June, 1914) has used the vaccine in four cases of ophthalmia of the new-born of gonococcal origin. The results were extraordinarily good. The vaccine is harmless. The three-fourths of a cubic centimeter injected had not given the slightest reaction or caused the least inconvenience. Its efficacy is incontrovertible. According to Roche, this vaccine is as efficacious in blennorrhea as the serum of Roux is in diphtheria.

Medalia (*Oph. Year-Book,* p. 39, 1914) furnishes a careful study of the results of vaccine therapy in eye diseases of bacterial origin, in a total of thirty-nine cases. His first case was one of infection of a cataract wound, with beginning hypopion, in an elderly woman. Smears and cultures showed staphylococcus aureus, and a few pneumococci. There was marked improvement twenty-four hours after a first treatment, with 150 million staphylococci and 40 million pneumococci, in stock vaccine. Six days later autogenous vaccine containing 250 million staphylococci and 40 million pneumococci was given. The patient was discharged soon after, perfectly recovered.

Of ten cases of this class treated along the same general lines, nine recovered perfectly from the infection and the remaining one improved. In six out of the ten cases the results as regards vision are described as brilliant, although the results optically depend on whether the use of vaccine is begun before permanent damage to the cornea or other structures has occurred. In all these ten cases the principal infective agent was a staphylococcus "weak aureus." The minimum number of treatments in this group was two, the maximum ten. The minimum duration of treatment was one week, the maximum seven weeks. The injection was repeated as soon as the reaction from the preceding inoculation subsided, the interval on this basis varying from twelve or twenty-four hours to two or three days or longer. In practically all the cases improvement was noticed twenty-four or thirty-six hours after the first inoculation.

The vaccine treatment was also used by Medalia in seven cases of perforating injury of the cornea with wound infection and hypopion. Five recovered, in one the outcome was doubtful, and in another the patient left the hospital against advice after five treatments. In four cases where the staphylococcus was the predominating organism, the results were invariably good as to infection. Where the pneumococcus was the principal infecting agent, although the acute infection ultimately yielded, the end results were not so good. Of fourteen cases

of ulcerative keratitis with hypopion, twelve were cured as to infection and two were discharged against advice before the treatment was completed. Three chronic cases of stye, in which the organism was staphylococcus aureus, and in which local treatment had failed, yielded promptly to the vaccine treatment. The same was true of a case of mucopurulent conjunctivitis of four years' duration, also due to staphylococcus aureus.

From a group of four cases of chronic dacryocystitis, three from streptococcus and one from staphylococcus and pneumococcus, Medalia draws the lesson that vaccine treatment will not succeed unless mechanical interference with proper drainage is overcome by the necessary surgical measures. The practice was to administer an initial dose of mixed staphylococcus and strepto-pneumococcus vaccine when the patient was first seen, employing an autogenous vaccine as soon as this could be prepared. In infections of the anterior chamber better results were obtained when the vaccine treatment was combined with repeated paracentesis than when the vaccine was used alone. Medalia regards the use of vaccines as of prophylactic value in preoperative immunization.

Paraspecific serotherapy by the mouth in diseases of the eye. Following Darier's suggestions his *chef de clinique* Léon Frogier (*Ophthalmoscope,* p. 534, Oct., 1915) advocates the exhibition by the mouth of antidiphtheritic serum.

He recalls the fact that since 1903 Darier had treated numerous non-diphtheritic affections of the eye by the injection of this serum, and had, in fact, constituted himself the champion of what has come to be called "paraspecific therapy" as applied to affections of the eye. This method of treatment depends upon the principle that in addition to their specific action, serums possess the property of giving to any organism invaded by an infective agent the elements of general defence, allowing it to resist up to a certain point the said infection. If treatment by antidiphtheritic serum does not invariably suffice of itself to put an end to the morbid process, at least it re-enforces powerfully any other therapeutic means that may be employed in a given case.

For some years Darier has advocated the giving of the serum by the mouth, and has found that it acts as well when administered by that as by any other route. One advantage of the method is, that when given internally, the serum never provokes anaphylaxis or serum sickness. The method has been tried successfully by Darier, Jacqueau, Verrey, Solm, Dor, Ruppel, Bersaque, and de Waele, to say nothing of Frogier, who has published details of eighteen personal cases. The

conditions treated by Frogier included membranous conjunctivitis, infective ulcers of the cornea (with or without hypopyon), plastic iritis, irido-cyclitis, and infections after injuries and operations.

In an acute infection of the eye it is of great importance to act quickly before irremediable damage has been produced. The vital resistance of all the tissues must be strengthened. The elements of defence may be found in the normal serum of animals, or, better still, in activated serum. The practitioner should employ the first anti-microbian serum on which he can lay his hands, and of these, anti-diphtheritic serum is usually the easiest to come at. Frogier recommends the following draught.—Antidiphtheritic serum, 10 cmc.; syrup of raspberries, 30 cmc.; water, 110 cmc. S.—A soup-spoonful to be taken every hour for the first three days, and every other hour afterwards. As soon as a bacteriological examination has allowed a precise diagnosis to be made, and if the paraspecific serum has not already cured the case, specific serum or vaccine may be substituted.

It is not claimed that paraspecific serotherapy is an infallible panacea. It is a powerful re-enforcement of the defense of the organism, a potent tonic which aids the body to resist the progress of infection. But if the last-named is too advanced or too virulent, nothing is able to stop it, a fact that must never be forgotten.

Frogier's more important conclusions are as follows:

1. Paraspecific therapy is a powerful stimulant of vital energy, which allows the organism to more easily resist infective agents.

2. The most constant result of paraspecific therapy is the relief of pain.

3. Intra-venous or subcutaneous injection is the surest and most scientific means of practising paraspecific therapy, provided the fear of serum accidents does not paralyze the ardor of the medical man and lead to the administration of inadequate doses, or cause the patient to reject this method of treatment altogether.

4. The administration of serum by the mouth, however, avoids all serum accidents, and by this means the administration of the remedy may be continued for several days.

5. The giving of serum by the mouth is as efficacious as by injection, and is free from danger.

6. Paraspecific serotherapy by the mouth relieves pain, prevents the progress of the infective process, and aids in the resorption of infiltrations and exudations and in the processes of repair.

Salvarsanized serum in ocular syphilis is advocated by E. G. Siebert (*Journ. Am. Med. Assocn.*, May 15, 1915). He regards it of importance that the serum should be injected subconjunctivally. It

was found that there was no more reaction from the serum than from ordinary salt injections: that it was rapidly absorbed and did not cause any great pain or inconvenience. Later, Lamb took up the work in the Freedman's Hospital. He reports, among others, a case of double plastic iridocyclitis of both eyes that had been treated for three weeks. The right eye had posterior synechiæ; the left eye had marked posterior synechiæ with a gumma, which was a very large one. The first injection cleared the right eye of the posterior synechiæ, the left was partially benefitted and the second and third injections improved the left eye, which finally healed, inflammation having subsided, with adhesions between that portion of the iris which had been gummatous and the anterior capsule of the lens.

Lamb also mentions a case of interstitial keratitis which was cured within three and one half months, whereas other methods take a year or more.

Lafont, Dupont, and Heckenroth (*Clinique d'Opthal.,* Jan., 1916) treated with *pure and combined sera* many cases of *ocular disease* in the natives of Senegal during 1913 to 1915. The results were very encouraging. In the discharges were found diplococci, staphylococci, and pneumococci, Weeks and Morax, and evidences of protozoa, syphilis, tuberculosis, leprosy, etc. When antidiphtheritic serum failed it was replaced by some other. The method was as follows: After a bacteriologic examination was made, the patient was given a wash of 1/5000 to 10,000 oxycyanid of mercury to use for two days, after which six to seven cubic centimeters of any therapeutic serum was injected into the back. At the same time a few drops of this serum were instilled in the diseased eye, which was then covered with a tampon saturated with the same solution and closed for twenty-four hours. The following days instillations and moist dressings of the serum were continued. Without the subcutaneous injections the local treatment with serum was decidedly less effective. Quinin and arsenate of soda proved valuable adjuncts. Every variety of serum had to be used, including antiplague, antitetanic, etc., and one seemed to act as well as another. Fresh sera from the patient or from one of his nonsyphilitic friends proved ineffectual, and their use is not advisable. The results were so favorable that natives came from all over the colonies for treatment.

Their conclusions are that these sera are the most efficacious means at our command to combat conjunctival and corneal lesions, and that all of Darier's findings are thus corroborated.

Takashima (*Ophthalmology,* p. 545, Apr., 1917) could not find any especial individual difference in the effects on rabbits of *eel serum* as

some have contended. With the gall, he was not able to obtain the effect so characteristic of eel blood, nor could he find the central influence against eel blood toxins by calcium salts as Steindorf maintained. The miosis which appears upon intravenous injections of eel blood is not alone due to the iris hyperemia but is also dependent upon the nervous shock. Injections of large doses may cause mydriasis. The isolated blood albumen is very toxic whereas the globulin has practically no influence.

Granular conjunctivitis (trachoma) and spring catarrh have been treated with heterogenous serum by L. Piccillo (*Annali di Ottalm.*, Vol. XLI, fasc. i-ii., pp. 3 to 16, 1914). Subconjunctival injection of the heterogenous serum of the horse or donkey (a specific serum prepared by Professor Bandi) was employed. In four cases of trachoma and in three of spring catarrh the injections (repeated five times in the first-named disease and ten times in the second) gave a negative result; as soon as the local reaction (pain, edema of the eylids and face, and sometimes fever) came to an end, the conjunctiva reverted to the *status quo ante.*

Seropathy in ophthalmology. SERUM THERAPY IN EYE DISEASES. VACCINES IN OPHTHALMIC PRACTICE. See **Serology.**

Serophthalmus. Associated with absence of tears. See **Lachrymal apparatus,** p. 6929, Vol. IX of this *Encyclopedia.*

Serous cyclitis. See p. 3623, Vol. V of this *Encyclopedia.*

Serous fluids. Various fluids occuring in the animal body are arranged by Gorup-Besanez under three heads: (1) Those which are contained in the serous sacs of the body, as the cerebro-spinal fluid, the pericardial fluid, the peritoneal fluid, the pleural fluid, the fluid of the tunica vaginalis testes, and the synovial fluid; (2) the tears and the fluids existing in the eyeball, the amniotic fluid, and the transudations into the tissue of organs; (3) morbid or excessive transudations, such as dropsical fluids, the fluids occurring in hydatids, and in blebs and vesicles on the skin, and transudations from the blood in the intestinal capillaries as in cases of intestinal catarrh, cholera, or dysentery. In so far as related to their physical characters they are usually clear and transparent, colorless or slightly yellow, of a slight saline, mawkish taste, and exhibiting an alkaline reaction with testpaper.—(*Standard Encyclopedia.*)

Serous iridochoroiditis. Cyclitis.

Serous iritis. See **Keratitis punctata,** p. 6805, Vol. IX of this *Encyclopedia.*

Serpents. The various products of the various serpents were, in Greco-Roman antiquity, esteemed as remedies for all wounds and numerous

diseases of the eyes. Serpent fat, mixed with cedar-wood, Attic honey and old oil was used in hypochyma (the modern cataract) and as a universal strengthener of the sight. The fat of the asp was especially favored in veterinary ophthalmology, the grease employed being that which lay directly underneath the skin. The flesh of the adder and the viper was sometimes eaten to improve the visual acuity, and the right eye of any kind of serpent, torn from the living animal (which, later, must be allowed to go at liberty again) was thought to be a sovereign remedy for epiphora. The gall of the boa constrictor was used in suffusio (cataract), but the gall of any other snake was supposed to be by far too poisonous for use, however small the dose. The worms passed from the body of a viper were rubbed up with saffron, and then made into an eye-salve for almost universal application.—(T. H. S.) See **Snake** headings.

Serpent ulcer. See p. 3447, Vol. V of this *Encyclopedia.*

Serpent virus. See **Snake bite.**

Serpiginous syphilide. See p. 5024, Vol. VII of this *Encyclopedia.*

Serpiginous ulcer of the cornea. See **Serpent ulcer of the cornea.**

Serre, August. A distinguished French ophthalmologist. See **Serre d'Uzès, August.**

Serre d'Alais, August. See **Serre d'Uzès, August.**

Serre d'Uzès, August. A distinguished French ophthalmologist. He was also called Serre d'Alais. Born at Uzès (Gard) Oct. 28, 1802, he received his medical degree at Montpellier, presenting as thesis "Essai sur les Maladies Périodiques sans Fievre." He then for a number of years devoted himself exclusively to the study of ophthalmology in Paris. At first he practised in his native town, but soon removed to Alais (hence "d'Uzès" and "d'Alais"). He invented an instrument known as the "Opsiometer," the purpose of which was to measure visual distances. He died at Alais, Aug. 24, 1870.

Serre's most important ophthalmologic writings are as follows:

1. De la Cautérization de la Cornée dans les Altérations de la Vue avec Dilatation des Pupilles. (*Archives de Méd.*, 1828, XVII.) 2. Du Phosphène ou Spectre Lumineux Obtenu par la Compression de l'Oeil, etc. (*Ibid.*, 4. Série, XXIV.) 3. Sur la Phosphène de l'Amaurose et dans ses Rapports avec la Myopie et la Presbytie. (*Ibid.*) 4. Sur la Rétinoscopie Phosphenique. (*Ibid.*, XXVI.) 5. Essai sur les Phosphènes ou Anneaux Lumineux de la Rétine Considérés dans leurs Rapports avec la Physiologie et la Pathologie de la Vision. (Paris, 1853.)—(T. H. S.)

Serre-fine. (F.) A small spring forceps invented by Vidal for catching bleeding vessels and controlling hemorrhage during operations.

Serre, Michel. A distinguished Monspellensian surgeon, of considerable importance in ophthalmology. Born at Montpellier Mar. 20, 1799, he there received his medical degree in 1825, presenting as thesis "Questions de Médecine et de Chirurgie." He rapidly rose to the full professorship of surgery at Montpellier, a position which he filled with great ability. He died May 22, 1840.

His most important writings are of a general surgical character. Relating to the field of ophthalmology, he wrote a number of journal articles on the cataract operation, on amaurosis, etc.—(T. H. S.)

Serum. (Pl. **sera** or **serums.**) The clear portion of any animal liquid separated from its more solid elements; especially the clear liquid (blood-serum) which separates in the clotting of blood from the clot and the corpuscles. Also, blood-serum from animals that have been inoculated with bacteria or their toxins. Such serum, when introduced into the body, produces passive immunization by virtue of the anti-bodies which it contains. For the various kinds of sera and their employment in ophthalmic therapeutics, see **Serology.**

Serum antidiphthericum. See **Antidiphtheric serum,** p. 514, Vol. I of this *Encyclopedia.*

Serum, Antistreptococcic. The bacilli of diphtheria and tetanus produce soluble toxins, which can be used in the immunization of animals with the resulting formation of antitoxins. In the case of certain other bacteria such as the streptococcus, staphylococcus, pneumococcus, and gonococcus, the toxins are to a large extent intracellular, and much greater difficulty is experienced in obtaining their corresponding immune sera. Moreover, different strains of streptococci vary greatly in virulence among themselves for the same animal, and different species of animals may exhibit wide variations in susceptibility to infection by any one strain. Several strains of virulent streptococci are usually employed in the immunization of animals, and the antistreptococcic serum produced is thus polyvalent. Antistreptococcic serum has been used in a large number of cases of cellulitis and other streptococcus infections, and many favorable clinical results following its use are on record, including severe infections about the face and eyes. There is a constant tendency, however, to report favorable cases, while the large number of cases not responding to treatment pass unnoticed. Moreover, the clinical course of streptococcus infections is proverbially uncertain and, as in pneumonia, this fact has led clinicians to attribute cures to the most diverse empirical remedies. For this reason, it is advisable to exercise caution in accepting favorable reports on the use of antistreptococcic serum, although it must be admitted that the serum has a certain

claim for recognition as a scientific attempt at specific therapy.—(E. E. I.) See, also, **Serology**.

Serum, Antitetanic. Antitetanic serum is obtained from horses immunized to increasing doses of the tetanus toxin. The greatest value of antitetanic serum lies in its prophylactic use in lacerated and deep puncture wounds in which experience shows that tetanus infection is likely to occur. Cases in which tetanus develops following lacerated or other wounds when the early prophylactic injection of a suitable dose of tetanus antitoxin has been made, are extremely rare. In cases which come under treatment after the symptoms of tetanus have appeared, the injection of the serum locally, intraneurally or by lumbar puncture is indicated. More recent work and clinical experience tend to show that these methods of introduction of the serum, while of some value, are not nearly so efficient as the intravenous method by which serum is introduced rapidly into the blood, avoiding the delay due to slow absorption which occurs in the subcutaneous method. The immunizing dose is 1,500 units. In the treatment of tetanus already developed, but little can be expected of small doses, and to be effective it should be given in large doses, best intravenously. Tetanus antitoxin is also supplied in powder form for local application to wounds. It is obvious that the application of such a powder can have but little influence on tetanus already developed. Many cases of tetanus undoubtedly have been saved by use of antitoxin, the beneficial results depending on the early neutralization of the toxin, before it has become widely diffused throughout the nervous system.—(E. E. I.) See, also, **Serology**, also under **Tetanus**.

Serum antithyroideum, Merck. See **Antithyroidine-Moebius**, p. 528, Vol. I of this *Encyclopedia*.

Serum, Autogenous. See under **Serology**.

Serum, Deutschmann's. See p. 3860, Vol. V of this *Encyclopedia*, as well as under **Serology**.

Serum, Dunbar's. See **Pollantin**, p. 10306, Vol. XIII of this *Encyclopedia*.

Serum, Heterogenous. See **Serology**.

Serum, Eel. See **Serology**, as well as p. 4159, Vol. VI of this *Encyclopedia*.

Serum, Polyvalent. See **Deutschmann's serum.** See p. 3860, Vol. V of this *Encyclopedia*.

Sesame. *Sesamum orientale.* In ancient Greco-Roman times, sesame, boiled in wine, was often employed as a poultice to the eyes or forehead in any acute affection of the eyes.—(T. H. S.)

Seton. A sinus established by piercing a fold of the skin with a knife-

like needle threaded with a strip of muslin, lamp-wick, or other material; also, the strip so used. See its employment in **Glaucoma,** p. 5557, Vol. VII of this *Encyclopedia.*

Seventh cranial nerve. The facial nerve (of motion) supplying most of the muscles of the face, ear, palate and tongue.

Sextant. An instrument for measuring the angular distance of objects by means of reflection. The principle of its construction depends upon the theorem that, *if a ray of light suffer double reflection, the angle between the original ray and its direction after the second reflection is double of the angle made by the reflecting surfaces.* The instrument of which this theorem is the principle is a brass sector of a circle in outline; the sector being the sixth part of a complete circle, for which reason the instrument is called a *sextant.*

Sexual diseases. This term is now often used for (and is probably an improvement upon) the older "venereal diseases," to include gonococcus infections, syphilis, chanchroidal affections, balanitis, etc.

Sexual organs, Eye affections due to condition of. This subject has been treated incidentally under a variety of captions. See, e. g. **Masturbation,** p. 7616, Vol. X; **Menstruation,** p. 7645, Vol. X; **Gestation,** p. 5371, Vol. VII; **Lactation,** p. 6988, Vol. IX; **Pregnancy,** p. 10335, Vol. XIII; and **Ovarian diseases,** p. 9204, Vol. XII of this *Encyclopedia.*

It must also be remembered that retinal hemorrhage and even optic atrophy may have resulted from excessive venery.

Sferule di Morgagni. (It.) Morgagnian spheres.

Sgrosso, P. A well-known Neapolitan opthalmologist. Born at Avellino, Italy, in 1856, he received his medical degree in 1883 at Naples. For the next three years he was engaged in medico-military service, but in 1887 became an assistant of De Vincentiis. Five years later he settled in Naples, where he lectured on the eye until his death, Mar. 24, 1900.

Aside from a number of journal articles, he wrote *"A Students' Guide to Ophthalmology"* (1899).—(T. H. S.)

Sguardo (Campo di). (It.) Fixation (Field of).

Shadow. UMBRA. As ordinarily understood, this phenomenon is the result of the interception of rays of light by opaque or semi-opaque substances. Close inspection of any shadow, whether cast by the sun or by an artificial light, shows that its margin is not clear cut. This is chiefly due to the fact that the source of light has a finite size so that there are certain regions from which the source of light is only partially screened. Other forms of radiant energy, such as radiant heat, sound, electric rays, may be intercepted, and corresponding

shadows cast. To appreciate the existence of sound shadows we must get our ear within the shadow, that is, with the obstacle between our ear and the source of sound. In such circumstances the intensity of the sound becomes very much diminished.—(*Standard Encyclopedia.*)

See, also, **Chiaroscuro,** p. 2038, Vol. III of this *Encyclopedia.*

Shadow bands. Phenomena observed during a total eclipse.

Shadow-crescent. The peculiar play of light and shade on the cornea noticed on examination of conical cornea by the ophthalmoscope or the ophthalmometer.

Shadowgram. SHADOWGRAPH. Same as skiagram.

Shadowgraphy. A synonym of skiagraphy.

Shadow-test. A synonym of skiascopy or retinoscopy.

Shadows, Colored. See p. 2390, Vol. IV of this *Encyclopedia.*

Shagreen of the lens. This term has been applied by Vogt (*Klin. Monatsbl. f. Augenheilk.*, Feb., 1915) to the roughened appearance of the anterior surface of the lens when examined with the Zeiss binocular microscope. It is best seen with at least a magnification of 24 to 48 diameters, and with Gullstrand's method of illumination.

The markings consist of alternate clear elevations and dark depressions arranged somewhat on the plan of the lens fibres. These, according to the writer, are due to the lens fibres. The appearances differ in coarseness in different individuals, but are independent of age, sex, and the presence or absence of eye disease. They are not so clearly seen when cataract is present, as they are readily concealed by diffuse reflected light. In one case of Vossius's ring opacity the shagreen was absent from the site of the opacity, but reappeared on clearing of the opacity.

An appearance described by Voght is that of *shagreen vacuoles* or *globules.* These are minute round spots, from one-sixteenth to one-thirtieth of a millimetre in diameter, seen in the lenses of adults from 20 to 80 years of age. They differ from the globules seen in senile lenses in that they are superficial, being only seen when the shagreen itself is in focus, and that they show considerable uniformity in size. There is no tendency to confluence. Sometimes they look black, but with a slight change in the direction of the light, they look like bright globules.

Shah Allum, the Second. A Prince of the Mogul Empire, or "Great Mogul," who, in the latter portion of his reign, was blind. The date of his birth is not known. He was, however, son of the Emperor Allumghir. Allumghir having been assassinated, Prince Ali Gober succeeded to the throne under the title of the Emperor Shah Allum the Second. He was the subject of numerous conspiracies led by his

own vizier, Gholam Kadir, to whom he seems to have been by far too liberal in pardoning. At all events, Gholam Kadir, as soon as he found a fitting place and time, put out his emperor's eyes with a poniard, for which crime he was put to death.

In 1803, when the English captured Delhi, Shah Allum was allowed to keep the nominal title of emperor, and was also granted a pension. He died in 1806, after a reign of forty-four years, the last of the House of Timur, or Great Moguls. He was followed in power by the British East India Company.—(T. H. S.)

Shakespeare, Edward Oram. A well-known American surgeon and ophthalmologist. Born in Delaware, May 19, 1846, he received the degree of A. B. at Dickinson College in 1867 and that of M. D. at the University of Pennsylvania in 1869. At first he settled in Dover, but soon removed to Philadelphia, where he became lecturer on operative surgery at the University of Pennsylvania. In 1873 he was clerk of the Senate in Delaware. A little later he was lecturer on the refraction and accommodation of the eye and on operative ophthalmic surgery at the University of Pennsylvania. He wrote a considerable number of ophthalmologic articles, the chief of which was "A New Ophthalmoscope and Ophthalmometer" (*Am. Jour. Med. Sciences,* Jan., 1876). Shakespeare died June 1, 1900.—(T. H. S.)

Shaking cataract. Tremulous cataract.

Shaking. Roughly trimming the edge of a lens by means of pliers; nibbling.

Sharpey, William. A celebrated Scotch anatomist and surgeon, who paid considerable attention to ophthalmology. Born at Arbroath, Scotland, May 2, 1802, he became in 1821, a member of the Royal College of Surgeons of Edinburgh, and afterward studied in London and Paris. For a number of years he practised in Arbroath. After a number of scientific journeys to the Continent, he settled in Edinburgh, where he became a Fellow of the Royal College of Surgeons, and professor of anatomy at the Edinburgh School of Medicine and Surgery. In 1836 he was called to London as professor of anatomy and physiology at the University College, as successor to Jones Quain. In this position he remained for thirty-eight years. He died April 14, 1880.

His only ophthalmologic writing is entitled "Account of the Discovery by Purkinje and Valentin of Ciliary Motions in Reptiles and Warm-blooded Animals. With Remarks and Additional Experiments" (Edinb., 1835).—(T. H. S.)

Sharpshooter. See **Sport.**

Sharp, Samuel. A famous London surgeon, who devoted much attention

to ophthalmology, and who was the first (in 1753) to employ a knife in making the corneal incision of a cataract operation.* Born in Jamaica, he began the study of medicine with Cheselden in London in 1724, the fee for his keep and training for seven whole years being £300. In 1731 his apprenticeship with Cheselden came to an end, and, the year following, he received the diploma of Master in Surgery and Anatomy. For a time he was surgeon at Guy's Hospital. In 1749 he became a member of the Royal Society of London and also a Fellow of the Paris Academy of Surgery. He seems to have been a sickly man, suffering especially from asthma. In consequence of this affection he made a number of journeys to Italy. He died Mar. 24, 1778.

His most important writings are as follows: 1. *A Treatise on the Operations of Surgery;* a Description and Representation of Instruments, etc. (London, 1739; 10th English ed. in 1782. There were also French, Dutch and Spanish translations. The work was dedicated to his old teacher, Cheselden, to whom he was greatly attached. It contained three chapters on ophthalmologic subjects: Cataract, Iridotomy—which had been invented by Cheselden—and Lacrimal Fistula. While treating of the last-named subject, he attacked, most unfortunately, the syringing treatment of Anel. 2. *A Critical Inquiry into the Present State of Surgery.* (London, 1750; 2d ed. 1761. There were also French, Spanish and German editions.) 3. A New Method of Opening the Cornea in order to Extract the Crystalline Humor. (*Philos. Trans.*, 1755, Abridg. X.) 4. On the Styptic Powers of the Agaric. (*Ibid.*) 5. Letters from Italy, Describing the Customs and Manners of that Country, etc. (London, 1766.) 6. A View of the Customs, Manners of Italy as they are Described in the Frusta Literaria. (London, 1768.)—(T. H. S.)

Sharpshooters. In addition to the material on this subject under **Marksmanship,** p. 7599, Vol. X of this *Encyclopedia* an abstract of an article by E. Krüekmann and Kern (*Prac. Med. Series,* Eye, 1916) is given as follows. Shooting glasses for emmetropes are intended for diminishing or removing a disturbing glare for the better discernment of distant small objects. In many cases it can not be decided whether the injurious effect on the eye is due to excessive intensity or to the wave length of the rays. To this uncertainty corresponds the variety of protective means. Hunters found empirically that yellow glasses have a certain advantage against glaring and increase the contrast

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* Daviel, the inventor of cataract extraction, made use, it will be remembered, of a lance and scissors. De la Faye, in 1752, proposed the use of a knife, but did not actually use one till after Sharp had done so.

action of colors. For this no satisfactory physical and physiologic explanation can be given, as exact quantitative measurements of contrast in different intensities of illumination and adaptation of the eye are lacking. Haitz explains the favorable effect of yellow glasses by the darker appearance of the blue shadows, which in nature are frequent in bright weather. Perhaps yellow glass may have advantages, still unknown, against an enemy dressed in khaki. Yellow glass transmits yellow rays unchanged but the short-waved (especially blue) rays are diminished.

The advantage of yellow glasses at dusk has been explained as follows: In subdued illumination and corresponding dark adaptation of the eye yellow and red hues appear darker; green and blue hues seem lighter. If through the yellow glass blue and green are physically diminished, the yellow colors become relatively lighter, and objects, e. g., yellow animals, more distinct. As these questions can not be decided theoretically, Krückmann recommends shooting glasses of euphos, or of Hallauer yellowish-green, and, in intense illumination, the old approved grey glasses.

Kern reports on the shooting results with different kinds of lenses, which demonstrate that the Punktal glasses are far superior to all hitherto worn. He considers, however, ordinary periscopic lenses to be amply sufficient for the army, provided they have higher degrees of crescentic curvature. The lenses must be large, round and a diameter of 4 cm., the distance from the cornea 12 to 13 cm., mounted in riding bows of hard nickel, and they should be worn constantly. Euphos and Hallauer glasses prevent glaring, but Krückmann considers this advantage not great enough for recommending their introduction into the army.

Shave grass. *Equisetum arvense.* Shave grass, or horse-tail, in ancient Greco-Roman times, was tied around the neck for epiphora.—(T. H. S.)

Sheath, Bonnet's. See **Bonnet's capsule,** p. 1248, Vol. II of this *Encyclopedia.*

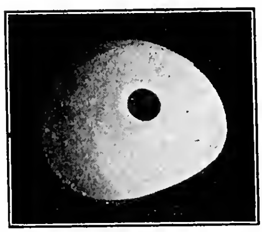
Sheath, Optic nerve. The envelops that surround the optic nerve, formed by extension of the membranes of the brain.

Sheep, The. The products of the sheep were much employed in Greco-Roman times for diseases and injuries of the eye. The ashes of burnt wool were esteemed as an all-round ocular remedy, and so, too, was the suet, even as now, especially among the laity. The filth that stuck to the wool of a sheep's hinder parts was much in favor, as a matter of course. Then, too, wool soaked in frankincense and the white of an egg was employed as a poultice in diseases of the eyes. It was laid,

however, not upon the eyes themselves, but upon the forehead.

Of especial interest is the way in which in Greco-Roman times the fat of the wool (our modern "lanolin") was extracted and preserved. The wool was placed in a copper kettle, and heated. Allowed to become cold, the supernatant fat was skimmed off and placed in an iron vessel. Again and again the wool was heated, and the fat again and again, when cool, removed. When all the fat had been collected, it was washed with water, and then, in a linen sack, exposed to the sun until it had become quite white and transparent. It was then preserved in a tin box, and, so far as ophthalmology was concerned, it was frequently employed by itself as a remedy in various inflammations and for all ocular contusions and also as a menstruum in the preparation of almost every kind of salve.—(T. H. S.)

Shell, Acid-proof glass. Apart from the ordinary uses of the artificial eye it must not be forgotten that glass and porcelain shells are occasionally employed to good purpose to prevent symblepharon after



Shell of Acid-proof Glass.

wounds, burns and operations on the lids. These are of two kinds; one sort, almost exactly like the artificial shell but adapted to the particular requirements of the case; a second variety, like the first, only pierced with a central aperture for the protection of the cornea, to permit the escape of secretions and to allow the entry of collyria to the globe and sac. See the cut.

Shell concussion. See **Shell shock.**

Shell eyes. The older form of artificial eyes. See **Prothesis, Ocular,** p. 10397, Vol. XIII, and **Artificial eyes,** p. 621, Vol. I of this *Encyclopedia.*

Shell for Röntgen rays, Protective. These are generally made of lead, and protect the eye itself when treating the parts surrounding the eye-ball. See **X-rays**; as well as **Shield.**

Shells for conical cornea and irregular astigmatism. See p. 2995, Vol. IV of this *Encyclopedia.*

Shell-shock, Ocular relations of. See **Shock amblyopia**; also **Military**

surgery of the eye, p. 7770, Vol. X; as well as **War, Ophthalmic medicine and surgery in,** of this *Encyclopedia.*

Shell wounds. See **Military surgery of the eye**; as well as **War, Ophthalmic medicine and surgery in.**

Protective Shell for Röntgen Rays, in Ocular Treatment.

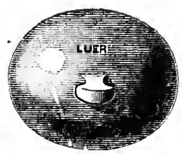
Protective Shells for Röntgen Rays in a Case.

Sherman, Harris Gray. A well-known ophthalmologist of Cleveland, Ohio. He was born at Kent, Ohio, June 6, 1856, son of Aaron M. and Harriet Adelia (Gray) Sherman. Receiving his medical degree at the College of Physicians and Surgeons in the City of New York in 1880, he settled at Cleveland in 1882 as ophthalmologist and oto-laryngologist, and soon had a very large practice. He became president of the Cleveland Library Association, president of the Cleveland Academy of Medicine, and a member of the American Ophthalmological Society. He was also one of the organizers of the New England Society and of the Sons of the American Revolution in Cleveland. Sherman was known as the "father" of medical inspection in the

public schools of Cleveland. He married, June 14, 1882, Miss Jane Sophia Bates, (who survived him) and died suddenly, of pneumonia, in Cleveland, Oct. 30, 1917.—(T. H. S.)

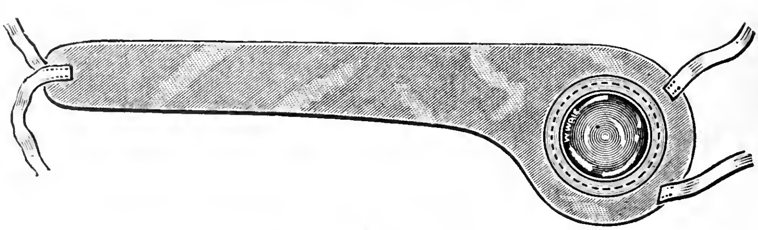
Sherrington's law. Exeessive stimulation of the centre for one (oeulomuscular) movement produees inhibition of the centre for the opposing movement. It is probable that this law explains the development of squint, the anomaly being eerebral and central, and not peripheral or muscular.

Shield, Bettremieux's X-ray. See the figure (*Clinique Ophtal.,* May 25, 1906); also, **Shell.**



Bettremieux's X-ray Shield for the Eye.

Buller's Shield, mounted with Rubber Sheeting.



Buller's Modified Shield.

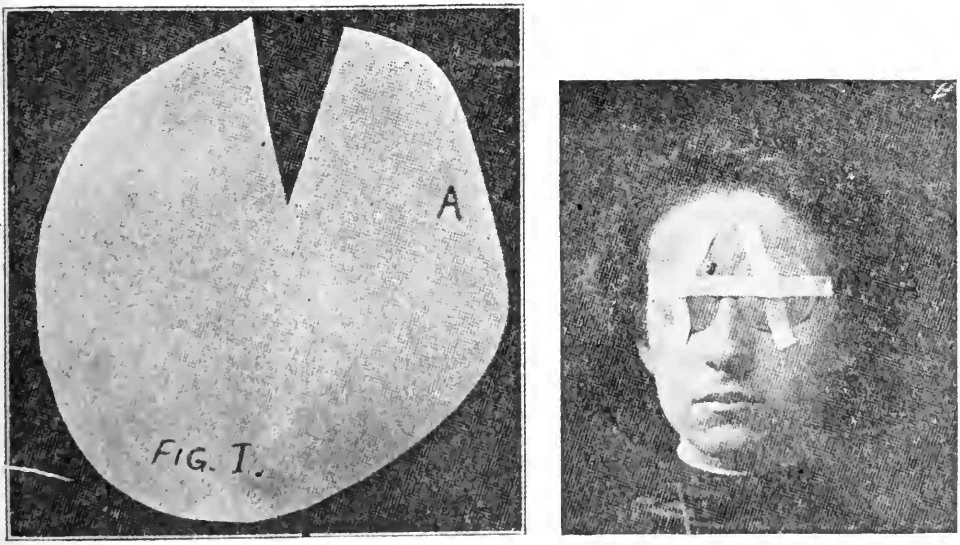
Shield, Buller's. A watch-glass fitted over the eye to guard it from gonorrheal or ophthalmie infection. See **Buller's shield,** p. 1336, Vol. II of this *Encyclopedia.* Improved forms of this protector are depicted in this text.

Shield, Eye. This subject is fully illustrated and discussed on p. 156, Vol. I; on p. 5034, Vol. VII; on p. 1652, Vol. III and elsewhere in this *Encyclopedia.* A few additional protectors of the sort are referred to here.

Fuchs's Shield.

Shield, Fuchs's. It is like the Fox-Snellen guard, made of aluminum. See figure.

Shield, Mitchell's. S. Mitchell (*Ophthalmic Record,* Feb., 1909), has tried nearly all the usual shields and dressings and like most of the operators of the present day, has discarded them and now uses only the simple dressing here described and illustrated.



Eye Shield after Operations. (Mitchell.)

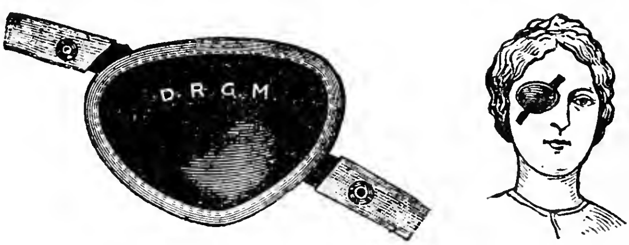
It is made from thin celluloid board, such as may be purchased from a dealer in artists' supplies. By means of a pair of small sharp scissors a piece of the board is easily shaped as shown in the first figure. This illustration is the exact size and shape of the shield. To give it the proper form for protection to the eye, the edges of the triangular notch are brought together and caused to lap one over the

other to the extent of one-fourth of an inch at the border of the shield, and secured in place by means of a No. 12 Crocker's "Best" paper-fastener. This gives the shield a low, flat, conical form with a border that exactly fits the parts about the eye.

In placing the shield over the eye, the more or less straight part of its border, marked A is to be in contact with the base of the nose.

The second figure shows the shield as applied to both eyes for the first three days following cataract extraction. Shields are secured in place by means of three narrow adhesive strips. The shield for either eye is cut in exactly the same shape; it is formed into a right or left one at will, by causing either surface to take the convexity. The reader can prove this to his own satisfaction by tracing a pattern from the illustration given here, and then cutting it out and making this pattern take the proper form to fit first the right and, then, the left eye. See p. 5034, Vol. VII, **Eye protector** and **Eye shade**; also **Cataract, Senile.**

Shield, Oppenheimer's. The illustration sufficiently indicates the form



Oppenheimer's Eye-shield.

and purpose of a practical ocular shield and shade devised by E. H. Oppenheimer. It is intended to be worn by patients during sleep, after operations that involve opening the eyeball, as well as to serve as an eyeshade in cases requiring ordinary protection during the day. This dressing is kept in place by plaster attached by means of a special button to the ends of the tapes, as shown in the figure. The plaster adheres to the forehead and cheek and is easily removable.

Shield, Supra-orbital. A plate or plates of bone at the upper edge of the orbits of certain birds, causing a marked projection of the eyebrows.

Shield, Theobold-Murdoch. This light, convenient and comfortably ventilated shield, for use after operations on the eye, is made ir two varieties, for right and left eye. It is made of aluminum and is one of the most effective post-operative protectors in the market.

Shiga-Kruse bacillus. Another name for the bacillus of dysentery. See p. 735, Vol. II of this *Encyclopedia*.

Shingles, Ocular. A popular term for *herpes zoster ophthalmicus.* See p. 5882, Vol. VIII of this *Encyclopedia*.

Shock amblyopia. According to Arthur Griffith (*Lancet,* June 24, 1916), four classes of this condition can be distinguished: 1. Transient blindness from over-stimulation of the retinæ. 2. Hyperesthesia of the retinæ resulting in blepharospasm. 3. True amblyopia (a) partial loss of vision with gradual recovery, (b) total blindness of one or both eyes, which remains unaltered for a time and is recovered from, either rapidly or instantaneously. 4. Ciliary muscle asthenia. See, also, **Shell-shock**; and **War, Ophthalmic medicine and surgery in**; also, **Military surgery of the eye.**

Shock in ophthalmic surgery. The sudden vital depression preceding, following and accompanying ocular injuries and operations is essentially the same as that seen in traumatisms and emotions connected with general surgery. Shock may be slight and temporary or it may be so profound as to cause death. In the severe forms syncope results, or the patient may be excited and restless. Increased temperature, respiration and pulse-rate follow recovery from surgical shock.

Although rather popular in its wording B. J. Hendrick (*McClure's Magazine,* Nov., 1916) gives a fair account of the subject and of Crile's method of combatting this condition.

Surgical shock, he says, is cerebral exhaustion, the loss of certain quantities of nervous energy stored in the brain. This phenomenon differs only in degree from the mental disturbance caused by stubbing the toe against a sharp stone or running a Marathon race. Certain operations produce slight cerebral disturbance and occasion only slight shock. Most make varying demands upon brain-energy and are responsible for the period of exhaustion that follows. In some cases, unfortunately in too many, the injury is so severe and so continuous that the cerebral cells are virtually destroyed, and death results.

In its practical effects upon the brain, the surgeon is really restoring the long-departed era of "tooth and claw." The external circumstances, for a man on the operating-table, are strikingly like those of his remote jungle-prowling ancestor. The patient suffers enormously from fear—that is to say, the anticipation of bodily injury. Everything about the surgical chamber suggests the terrible things that are to come. The anxious faces of his relatives, the corrugated brow of the surgeon, the quickly moving white-robed nurses, the white iron bedstead, the bare sanitary walls of the hospital, the pervading odor of ether—in all these things the weary, harassed brain foresees

only the forthcoming laceration of tissues. The mere sight of surgical instruments in itself produces a certain quantity of "surgical shock." The administration of the ether and the suffocation that accompanies it are responsible for the wildest kind of "brainstorms." All this, of course, is emotional, "psychic," the working of mind upon matter; but the effect upon the brain-cells is just as physical as bodily injury.

The operation that follows even more vividly reproduces man's primordial struggles. For only those parts of the body are susceptible to shock that were the most popular points of attack in the days of the jungle. In that far-off time it was particular areas—the abdomen, the chest, the neck and throat, the hands and feet, the lateral walls of the trunk—that had constantly to defend themselves against attack; These sections developed, as has been described, certain "nociceptors," or fire-alarms. Other parts, especially the brain, were so well fortified that this protective apparatus was not evolved. Consequently, the brain, at the surgeon's hands, can not possibly be shocked. The surgeon can entirely destroy one hemisphere without causing the slightest "exhaustion." Operations for brain tumors, which are very common to-day, are, therefore, entirely free from this danger.

Harsh treatment of the abdominal region produces the most serious effects. Even here, however, the effects of man's ancestral experience show themselves; for it is only when this area is subjected to the kind of handling similar to that it received millions of years ago—tearing and crushing with the teeth and claws of animals—that surgical shock results. The intestines, for example, can be completely burned without causing any pain or any "shock." They can be cut in two with a sharp knife, and no injury to the brain results. The explanation is that ancestral man, in order to survive, did not have to protect his intestines from burning or sharp cutting, and therefore he developed no protective machinery against injuries of this kind. He did have to protect them from tearing and crushing; consequently, when the surgeon handles the intestines roughly to-day, nature's old protective apparatus starts working again, and manifests itself in "shock." Modern surgical phraseology recognizes this fact, for the surgeon who is particularly rough and "rapid" is professionally stigmatized as "canine." A "quick" operator is usually a dangerous man. His mortality from "shock" is likely to be large.

Surgical shock, therefore, is composed of two factors: psychic, or the disintegrating effects of tense emotion, and "traumatic," or that which is caused by tissue laceration—anticipation of injury, and injury itself. The patient's position is that of the engineer or fireman in a railroad disaster. He suffers the emotional anticipation of the

smash-up, and is also physically injured. In other words, he is usually shocked twice. The only way to recover from cerebral exhaustion is by resting; the battery must be recharged; if there are sufficient intervals of quiet between successive crises of psychic and traumatic shock no permanent injury results.

Nothing seems less consequential than the falling of a single drop of water on the body. This drop produces an infinitely small amount of shock; however, a single instance is nothing. When one drop succeeds another before the injured area has had time to recover from the slight shock inflicted, the procedure ultimately becomes one of the acutest forms of torture. It was a form of inflicting pain especially popular in the middle ages. Similarly, a prolonged surgical operation which lasts for many hours, and in which injury is piled upon injury, with no intervals for recuperation, tremendously strains the brain-cells. A death from emotional tension, or from a "broken heart," is an illustration, in the mental state, of the same thing. The brain will suffer no permanent injury if between successive emotional crises there are periods of emotional normality—of "resting." But continuous tension, the unending brooding or worrying, the sleepless nights constantly following the harassing days, have exactly the same chemical effect upon the brain-cells as has the steady, uninterrupted drop of water on an exposed surface of the body.

At this point, however, there is apparently one distinction. The medieval sufferer, under the water-drop form of torture, was entirely conscious; the modern patient, under the surgeon's hands, is in the deep sleep of anesthesia. What effect does the anesthetic have upon that part of shock that comes from physical injury? The fact of the matter is that, under chloroform and ether anesthesia, only a small part of the brain is really asleep.

The beautiful thing about ether is that it puts asleep the seat of consciousness without disturbing the other sections of the brain. Now the stimulus of injury is carried to the brain, and the released energy dashes back to the injured part by way of the nerves. No matter how deep our anesthesia, this mechanism is still in active operation. The brain suffers all the exhausting injuries, only it knows nothing about them. But the practical effects are just the same as if it did. The condemned murderer would probably experience much relief if we should anesthetize him before hanging; no one suspects, however, that the anesthesia would at all minimize the actual results of the hanging.

Crile's remedy for both psychic and traumatic shock is the new elaborate procedure which he calls anoci-association. The word means, as he describes it, "the exclusion of all nocuous or harmful associations or stimuli."

Here, for example, is a man who is about to be subjected to a long and difficult abdominal operation; the kind, as already said, that is most likely to produce shock. The preliminary dread, even with the most strong-minded men, is intense, and the task of overcoming or minimizing this dread is a problem that is solved partly by psychology and partly by drugging. The personality of the surgeon counts for much. The selection of the proper kind of nurses, the maintenance of a helpful attitude by friends and family, are all important.

A favorite plan is not to let the patient know when the operation is to take place. On several successive days a slight anesthetic is given, ostensibly for the purpose of examination. When the suitable moment arrives, this anesthetic is given in earnest, and the operation performed. A little morphin and scopolamin, injected about an hour before the operation, works wonders in the same direction. For fear, as already described, is a product of what the psychologists call "association of ideas." The sight of a knife suggests cutting, that of a fire suggests burning. But morphin produces one amazing effect upon the brain, in that it deprives it of this power of associating one thing with another. A man who is sufficiently "doped" is never a coward and never a hero, because he has no power of connecting any act with its consequences. Consequently, after Crile's patient has received these few doses of morphin he no longer has the slightest apprehension about what is to happen. All danger of "psychic shock" has disappeared.

In this way "psychic shock" is largely eliminated, but the much more serious problem of "traumatic shock" still remains. As explained above, patients are shocked under the anesthetic precisely as they would be shocked under full consciousness, because the nerves, like telegraph wires, are still connected with the brain. Clearly, there is only one way to prevent the lacerated tissues from telegraphing for assistance and thus inducing nervous exhaustion, and that is by cutting the wires. If the surgeon, for example, were able to block out his zone of operation, and then cut with his knife every nerve that gave this region communication with the brain, the stimuli of injury would never reach it. The operation area, for practical purposes, would be as isolated as if the surgeon had excised it and carried it into an adjoining room.

Naturally, there are practical objections to cutting these nerves with a knife. A local anesthetic, however, such as cocain or novocain, accomplishes this result quite as well. These drugs destroy sensation in the parts of the body to which they are applied, because they paralyze the nerves; make them incapable of transmitting feeling or

motion; in other words, they "cut the wires." The surgeon, as Crile has discovered, can perform the most prolonged and radical operations in an area blocked off in this fashion, without producing the slightest deteriorating effects upon the brain. Modern surgery has regarded that terrible feeling of exhaustion which follows long operations as inevitable. Under anoci-association, however, there is no exhaustion, because there has been no expenditure of nervous force; the modern scientist has cunningly cheated even so clever a mechanician as Nature herself, or, as Crile expresses it, has won "in a game of biologic chess."

The records of the Lakeside Hospital in Cleveland, where Crile works, show that the death-rate, under the old ether procedure, was slightly more than six in a thousand. Under anoci-association, the death-rate is less than one in a thousand. In other words, the dangers of death from shock have been reduced practically to the vanishing-point.

Shooting, Ocular requirements in. See **Sport.**

Shooting glasses. See **Sharpshooters.**

Shop oculist. This is the title bestowed on the workman (found in most shops and factories) who has had considerable experience in removing cinders, emery, etc., from the eyes of his fellow employees. He usually has a steady hand and good eye, and has two or three instruments and a magnifying glass with which to remove the foreign body. These tools are hardly ever clean, and he himself makes no pretense at being surgically clean. He gets the patient in a strong light, and picks and scrapes the delicate tissues of the eye until he dislodges the little particle. At least, he tries to dislodge it, and frequently succeeds, but almost invariably leaves behind much scratched and roughened tissue. As a rule, the eye gets well, for a strong man can withstand much physical misfortune, but even if he gets well, the unnecessary scraping leaves a scar, usually in the center of the eye, which more or less permanently interferes with vision. Frequently the dirty and unskillful manipulations of the "shop oculist" produces an infection or poisoning of the eye, and pus forms and the eye becomes lost or very badly damaged, and the other eye even may be lost from sympathetic inflammation. The "shop oculist" is responsible for many eyes that are lost by improper treatment directly after a slight injury.

Shortening operations. See **Muscles, Ocular.**

Shortsight. Shortsightedness. Myopia.

Shortt, Thomas. A well-known Scotch physician, who devoted considerable attention to ophthalmology. Born in Scotland, he studied in Edinburgh where he graduated in 1815. He was physician extraor-

dinary to the King for Scotland, physician to the Royal Infirmary and to the Fever Hospital, Fellow of the Royal Society and of the Royal College of Physicians in Edinburgh, as well as professor of clinical medicine at the School of Medicine and Surgery. His only ophthalmic writing was "Remarks on the Treatment of Amaurosis by Strychnine." (*Edinburgh M. & S. Jour.*, XXXIV, 1830). The date of his death is not known.—(T. H. S.)

Shot-silk phenomenon. SHOT-SILK REFLEX. See **Reflex, Watered-silk.**

Show-glass. A magic mirror.

Show-stone. A magic mirror of quartz crystal.

Shrapnel wounds of the eye. See **Military surgery of the eye,** especially p. 7715, Vol. X, and under **War, Ophthalmic medicine and surgery in.**

Shrew-mouse, The. The ashes and the fat of the shrew-mouse, mixed with Attic honey and antimony, were, in Greco-Roman antiquity, rubbed into the eyes as a cure for epiphora. Pliny also relates that, if a pregnant woman eats a mouse, the gestating child will be born with black eyes.—(T. H. S.)

Shrinkage of the eyeball. SHRINKING OF THE EYE. PHTHISIS BULBI. ATROPHY OF THE EYEBALL. See p. 667, Vol. I; and p. 9716, Vol. XIII of this *Encyclopedia.*

Shriveling of the iris. See **Iris, Atrophy of the.**

Shrunken conjunctival sacs. See **Skin-grafting.**

Sibling. One of two or more offspring of the same parents

Sichel, Julius. A celebrated French ophthalmologist, founder of the first ophthalmic hospital in Paris, and one of the greatest savants as well as dextrous operators of all time. Born at Frankfort-on-the-Main, Germany, May 14, 1802, the son of a Jewish merchant, he studied medicine at Tübingen * and Berlin, at the latter institution receiving his degree in 1825. His dissertation on this occasion was entitled "Historiae Phtheiriasis Internæ Fragmentum." From 1825-29 he was assistant at Jaeger's Ophthalmic Hospital in Vienna, and, the year following, at Schoenlein's Hospital in Würzburg. In 1830, on the advice of Jaeger, however, he settled in Paris. Two years later he founded the first ophthalmic hospital (a private one) in that city, and this institution he directed until his death. He became in succession Lecturer on Ophthalmology at the Hôpital St. Antoine (by the kindness of August Bérard), oculist to the educational institutions of the legion of honor, permanent honorary president of the International Ophthalmological Congress, and honorary president of the German

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* According at least to Stricker; according, however, to Hirschberg, at Würzburg.

Medical Union at Paris. As an operator he was unexcelled, if equalled, and his reputation was world-wide.

Sichel was also active in other fields than medicine: in history, philology, archeology, and entomology. And in all these fields he conquered a more or less lasting renown. Preeminently a man of sorrows (for he lost his wife, his fortune, and—undeservedly—very many friends) he seemed to find, as was often pointed out, his chiefest solace in the unremitting activity of his intellect. A trifle vain, a trifle over-positive in manner and opinion, a trifle punctilious in matters of priority, he was, as even his greatest foes were obliged to admit, a true, warm-hearted man, a well-wisher of his kind. He made a large collection of ancient oculistic seals, and for some of these he gave large sums, even when financially embarrassed. He also made an immense collection of hymenoptera. For this the British Museum offered him a large sum, but Sichel, like a true Jew (the man so often supposed to be "without a country") contributed his collection gratis to his adopted city. Many other instances of Sichel's patriotism could be adduced. Then, too, he was very friendly to the poor. To these he gave not only of skill and time and strength, but also of his money—whenever he had that winged article at command. And the man himself died poor!

He suffered for a long time from a painful disease of the bladder. Worn out at last, he submitted to an operation—and succumbed. One of his latest expressions was (and it is wholly characteristic of the man) "So long as the head is clear, I am well enough." He died Nov. 11, 1868, and a pang of sorrow was felt throughout the world of ophthalmology, as well as by the wider world, so far as it had known him.

A full list of the writings of Sichel would occupy so many pages that it is here omitted.—(T. H. S.)

Sicherheitsnadel. (G.) Guarded needle.

Sichtbarkeit. (G.) Visibility.

Sick headache. See **Migraine**, p. 7694, Vol. X of this *Encyclopedia*.

Sickness, Car. The well-known symptom-complex of sea-sickness may be produced by journeying in railway cars. See **Car-sickness**, p. 1427 Vol. II of this *Encyclopedia*.

Side-chain theory. LATERAL CHAIN THEORY. EHRLICH'S SIDE-CHAIN THEORY. This theory presupposes that the stimulating substances introduced into the circulation have the power of combining with certain groups of molecules in the protoplasm of certain cells; which combination is succeeded by a regeneration of the lateral chains. When more of the combining substance is injected, and the combin-

ing lateral chains again consumed, another still more copious regeneration occurs, and so on until the particular lateral chains are present in great excess and pass out of the cells into the blood, where they are known as antitoxin (Gould). See, also, **Immunity,** p. 857, Vol. I of this *Encyclopedia.*

Side-reflector. A small concave mirror used to throw light on to the stage of a microscope.

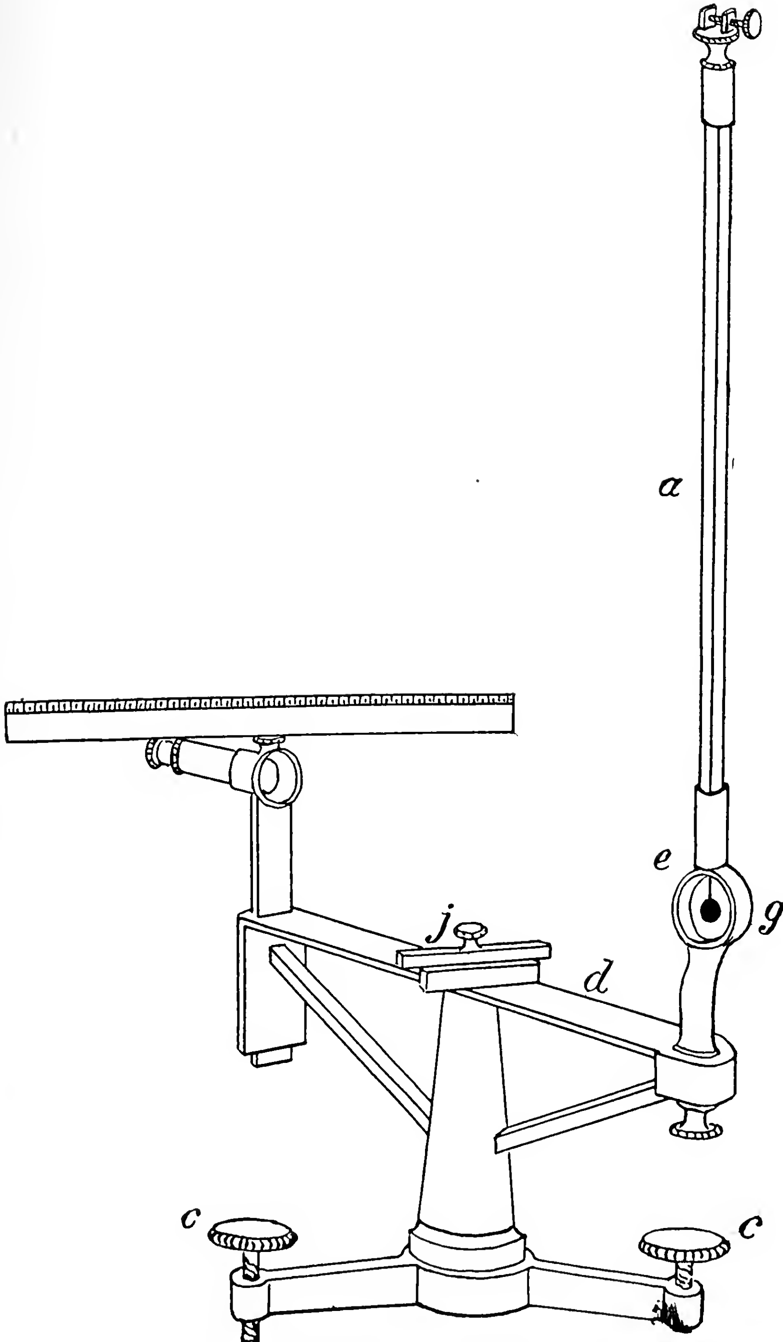
Siderophone. This instrument was devised by Jansson for the detection of pieces of iron or steel within the eye. It consists of an electromagnet to which a telephone is attached. When brought near a piece of iron a change is produced in the electric current, and this produces a sound in the telephone which can be easily heard.

Sideroscope. A magnet needle or other appliance for determining the presence of metallic iron as a foreign body in the eye.

The first to use the magnetic needle for the diagnosis of the presence of magnetic foreign bodies within the eyeball was Thomas R. Pooley who performed numerous experiments and demonstrated the delicacy of the method. He tabulated the deflection of the needle by particles of different sizes at various distances from the needle, both magnetized and unmagnetized. This was the first use of the method in connection with the eye, although it had been used in general surgery.

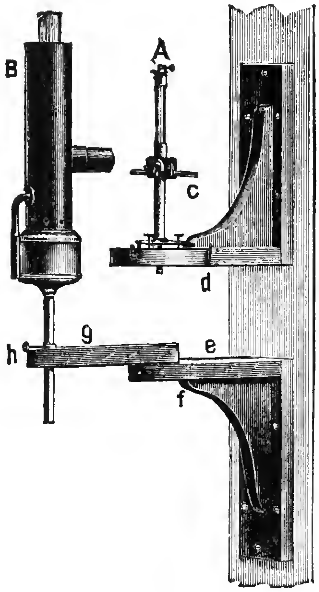
The idea was later elaborated by Asmus, who constructed an instrument containing a magnetic needle suspended by a silk thread in a glass tube. See Vol. I, p. 640, of this *Encyclopedia.*

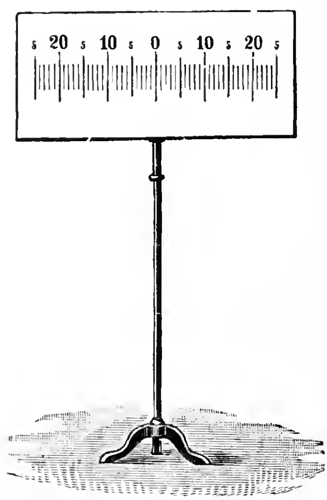
The magnetometer of Léon Gérard. At about the same time as the publication of the preceding instrument, Gallemaerts demonstrated another sideroscope—the magnetometer of Gérard. This consists of a base with three levelling screws (c) supporting a horizontal bar, on one end of which is the apparatus containing the magnetic indicator (g) and on the other the scale and telescope for noting accurately the deflections of the indicator. The horizontal bar (d), is of copper and 40 cm. in length. The indicator is composed of six little bar magnets, each of which is 6 mm. long, 2 mm. wide, and 1 mm. thick, and is suspended by a thread of silk which extends from a small button through a glass tube (a), and is enclosed in a cylindrical compartment about the size of the eyeball, closed before and behind with glass. The button at the top of the tube allows one to raise and lower the indicator so that it hangs free. One "window" of the compartment which contains the indicator is concave so that the eye to be examined may be brought as closely as possible to the magnetized indicator. On one side of the indicator is a small concave reflecting



Gérard's Magnetometer.

mirror, 6 mm. in diameter. The telescope points directly at the mirror of the indicator and through it can be observed the reflection of the rule which is placed over the telescope. The telescope contains cross-threads for centering, and the slightest deflection of the indicator can be accurately estimated. Upon the horizontal bar (d) is placed a small magnet (j), 5 cm. in length, which permits one to modify the direction of the indicator by approaching or withdrawing it, thus augmenting or diminishing the indicator's sensibility.





Hirschberg's Sideroscope and Scale.

Hirschberg's sideroscope. Hirschberg has modified the sideroscope of Asmus by adding an apparatus which throws a beam of light on a mirror, which is then reflected to a graduated scale. See the illustrations. The instrument is first regulated so that the beam falls on the zero of the scale, then the eye of the patient is approached to the glass tube containing the magnetic needle. Should a chip of iron or steel be present in the eye, the spot of light will travel along the scale. The larger the particle the greater will be the extent of the deviation.

Jonssen's sideroscope. See **Siderophone.**

Other sideroscopes are those of Hertel—a modification of the Asmus instrument—that of Spuler (also another form of the same device)

and a cheap but useful invention by Bane (*Annals of Ophthalm.*, p. 407, April, 1915).

Advantages and limitations of the sideroscope. All these instruments are of extreme delicacy, and are capable of giving very good results, but the use for them has to a great extent passed away since the introduction of the Roentgen rays, which determine the presence, location and size of the foreign body at one and the same time. In using them, it is necessary to be sure that neither the patient nor the examiner has any magnetizable metal about the person—keys, penknives, etc. The instruments are so sensitive that the needle or indicator can be deflected by particles of iron or steel in the hair, and if the examining room is within a short distance of an electric car line or other powerful electric current, they are very difficult to manage. (Asmus.) In using them, the injured eye is brought as near as possible to the magnetic needle or indicator, and it is noted, by the mirror or the telescope, as the case may be, whether a deflection has occurred. At times the indicator remains immovable, even when the foreign body is present, and in this case the foreign body must be magnetized by approaching an electro-magnet to the eye, after which a fresh attempt may be made. If still no deflection occurs, there is probably no magnetic particle present, although this, of course, does not exclude particles of other substances than iron or steel.

The sideroscope of Asmus, on account of its peculiar structure, is also of value in approximately localizing the foreign body. By approaching successively different parts of the eye to the needle and noting the spot of greatest deflection, and also the direction of the deflection, a fair idea of the situation of the particle may be obtained, if it lies in the ciliary region, or anterior. Where the particle lies in the posterior segment, the angles made by the different positions of the needle are not so great and the localization is rather vague—as indeed it is in any case compared with the results of localization by the X-rays. The amount and strength of the deflection leads one to infer something as to the size of the particle, a stronger deflection meaning a relatively larger particle. However, it must be remembered that in the absence of precise knowledge as to the distance between the needle and the particle, our inferences are bound to be only roughly approximative. If the deflection is very strong, it is difficult to localize the particle on account of the erratic movements of the needle, and it is best, under these circumstances, to render it less sensitive by placing a second magnetic needle parallel to the needle of the instrument, but in such a manner that the north pole of the second is opposite to the south pole of the first. The instrument is then

readjusted, and, as the needle is much restrained in its action by the presence of the other, when the patient is brought near the deflection is much less marked and the localization can be much better done. (Béal.)

The advocates of the sideroscope and those who have used it enough to master its technical difficulties—which are not slight—are enthusiastic over its powers, and there is no question but that it has been of great service in the past. Gruening says that "in 25 successive cases observed at the University Eye Clinic in Breslau in 1893 and 1894, fragments of iron or steel were detected by this instrument." Asmus still writes enthusiastically of it and reports a case in which the sideroscope was successful after the X-rays and Haab magnet had failed. However, the localization of foreign bodies by the X-ray is so far superior in point of accuracy that it is hardly conceivable that any one should of choice select the less perfect method at the present time. The sideroscope has only one advantage over the X-ray—that of time—and it is a great question whether the thirty or forty minutes necessary for an accurate skiagraphic examination are to be weighed in the balance. Moreover, in large institutions, or in offices in large cities, the electrical disturbances are so great that the delicacy of the instrument is seriously hampered—although Asmus reports good results with Koster's device for obviating these disturbances. It is possible that in smaller places, where the disturbances are not so great and where the X-ray apparatus is not obtainable, the sideroscope may still be used with advantage.—(E. S. T.) See, also, Vol. I, p. 639, of this *Encyclopedia*.

Sideroscopy. The detection of pieces of iron and steel in the eye by means of a magnetized needle, the X-ray, and by other means.

Siderosis of the eye. SIDEROSIS BULBI. When particles of iron remain for long periods within the eye or are imbedded in its tissues, all parts of it may be stained a rusty-brown by the deposit of ferruginous salts.

Von Hippel distinguishes two kinds of siderosis, viz.: *xenogenous siderosis*, due to the presence of a foreign body which is of iron or of steel; and *hematogenous siderosis*, following hemorrhages and due to the iron (hemosiderin) which is usually present in the blood.

The two following methods are for the chemical detection of iron in the eye. As a matter of course, no iron or steel teasing needles can be used in staining with these methods.

Perls' reaction.—The eyeball should have been hardened in formol or alcohol. Von Hippel claims the reaction may be obtained with specimens which have lain for years in Müller's fluid, although it appears more slowly. 1. Place the sections in a 2-per-cent. strength

aqueous solution of ferrocyanid of potassium for a few minutes. 2. Then place them in a 5/10- to 1-per-cent. strength solution of hydrochloric acid. 3. Wash the sections in water. 4. Clear the specimen and mount in balsam. If a nuclear stain is also desired, the following staining method may be employed: 1. Stain the sections in lithia-carmin for from one to two hours. 2. Wash in water. 3. Stain in a 2-per-cent. strength solution of ferrocyanid of potassium for from four to six hours. 4. Allow the section to remain in a 1-per-cent strength solution of hydrochloric acid for from six to twelve hours. 5. Rapidly wash in water. 6. Dehydrate in alcohol. Origanum-oil. Balsam.

The pigment containing iron stains intensely blue.

Quincke's reaction.—1. Place the sections in a freshly prepared solution of ammonium sulphid for from ten to twenty minutes—until they have acquired a dark-green color. 2. Rinse in water. 3. Alcohol. 4. Oil. Balsam.

Should a nuclear stain be desired, the sections may be stained with alum carmin before or after placing the sections in ammonium sulphid. The iron appears in the form of dark-green granules.—(J. M. B.)

Parsons (*Pathology of the eye*, p. 1176) gives a good account of this condition and draws attention to the fact that Bunge (International Congress, 1890) furnished the name *siderosis bulbi,* although the subject had been previously investigated by Leber in 1881. He believed that the iron was dissolved by the carbon dioxide of the tissues and converted into the carbonate. This salt, circulating in the vessels, was finally deposited as an insoluble compound by the acid salts of the blood. Bunge divided the process into *immediate,* i. e., brown staining in the neighborhood of the foreign body—as seen in the cornea—and *remote,* i. e., staining of distant tissues from a retained particle of iron, as in discoloration of the iris.

E. von Hippel (*Archiv f. Ophthalm.,* 40, 1., 1894 and 42, 4., 1896) bases his first series of observations on seven cases in which particles of iron had remained in the eye for periods varying from ten days to seven years. Of these five were imbedded in the globar walls, one was in the vitreous and one in the inner surface of the ciliary body. In all cases the retina was degenerated and Perls' reaction was positive. Von Hippel noticed that the blue of the test was always most pronounced in the immediate neighborhood of the foreign body. Xenogenous siderosis, he thinks, is due to solution of iron by the carbon dioxide of the tissues. This is diffused throughout the eye and fixed by cells which have an affinity for iron. In hematogenous siderosis the iron being already in soluble form is immediately fixed by the same cells.

Leber and Bunge, on the other hand, suppose that the oxidization of the iron compound is effected by free oxygen derived from the arterial blood supply; and Bunge found the staining densest near the arteries. It is probable, says Parsons, that von Hippel laid too much stress on the possibility of hematogenous pigmentation in these eyes, as in many of the cases the amount of exuded blood is very slight; so that the quantity of iron available for discoloration from that source is small as compared with the foreign body. It is likely therefore, that almost all the staining, including that of the cornea, is distinctly xenogenous.

Kipp (*Amer. Jour. of Ophthal.*, August, 1906) reported a number of examples of siderosis bulbi. He had seen some cases in which the cornea was stained brownish for some distance around a fragment of iron which had been lodged in it for weeks, but never from iron located in the lens or deeper in the eye.

The change in the color of the iris was seen only in cases in which the yellowish-brown dots arranged in the form of a wreath under the anterior capsule of the lens were present at the same time; both a yellowish-brown and a greenish-brown discoloration were observed, but the first more frequently. Attention was called to the occurrence of a similar discoloration after extensive hemorrhage into the vitreous and sometimes into the anterior chamber.

The change which he regarded as of greater practical importance, was the appearance of the yellowish-brown spots under the capsule to which repeated reference has been made. They are of round form, less than ½ a mm. in diameter, are of a yellowish-brown color, and appear at regular intervals of a mm. or two, in a circle, in or about the capsule of the lens. In addition to these spots there often are others on the anterior capsule, also of a yellowish-brown color, but situated much nearer to the anterior pole—the remains of broken posterior synechiæ. The spots behind the capsule are only seen after nearly ad maximum dilatation of the pupil. The writer had seen these spots in eyes in which the lens was still transparent and in which the capsule had not been ruptured. In all the cases in which they were present a fragment of iron was found back of the lens. Before the days of the sideroscope, he had repeatedly cut open the eye and extracted the fragments of iron by means of the small electro-magnet, on no other evidence of the presence of iron in the eye than the spots here described. He would not hesitate to operate, if both the Roentgen ray picture and the sideroscope failed to reveal the presence of iron in the eye, if the spots here described, together with the discoloration of the iris, were present.

Among other symptoms of siderosis bulbi are mentioned ochre-coloring of adhesions between iris and lens, spontaneous mydriasis, spontaneous subluxation of the lens, torpor of the retina, concentric contraction of the visual field and defective color perception.

The question why the lens spots beneath the capsule are almost uniformly found in the same region and of the same form has as yet not been satisfactorily answered, and this also applies to the question why do not all eyes containing fragments of iron give outward evidence of its presence. The length of time intervening between the entrance of the foreign body and the first appearance of outward signs of siderosis seems to vary considerably; in all of the writer's cases the iron had entered at least six months before the patient was seen.

Danis (*Le Progrès Médical*, June, 1913) mentions that late results of iron in the eye are mostly chemical (siderosis) and of irritative origin (glaucoma and sympathetic ophthalmia). Siderosis is due to the impregnation of the tissues with insoluble iron salts, forming ferrous carbonate and oxide of iron. The cornea rarely suffers, but occasionally with a loup the posterior epithelium is found to have a brown or yellowish hue. The iris, most often affected, becomes green, yellowish-red or reddish-brown, either in its entirety or sector-shaped. Impregnation of the ciliary muscle produces miosis or mydriasis. The lens may show a brown patch or even become absorbed. The vitreous is discolored and finally presents hemorrhages. The retina, usually affected by direct contact, shows large areas of brownish pigment. The prognosis in these cases is bad, as the iron retained in the eye produces further damage. The siderosis itself is incurable, even when the source is removed. Two cases alone have been reported by Cramer and Rogman where resolution occurred and vision was held.

J. Gray Clegg (*Ophthalmoscope*, October, 1915; W. R. Parker's review in the *Annals of Ophthalm.*, p. 112, Jan., 1916) reports seven cases of siderosis from retention of intraocular foreign bodies. The writer believes that although the condition is most commonly the result of the lengthened stay of a particle of iron or steel in an eye, it may also appear after severe intraocular hemorrhage.

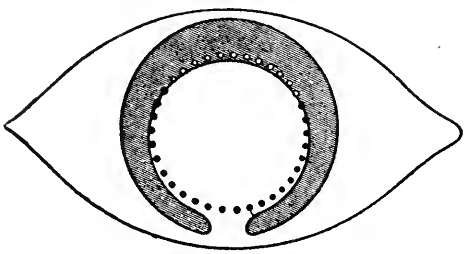
Copper or brass particles are most prone to set up a severe inflammation sooner or later, destroying the eye. On the other hand, iron or steel particles may be tolerated for years. The presence of such iron or steel particles in the conjunctiva, sclera or cornea may be tolerated with practically no siderosis. The iris may tolerate a chip well, as in a case of Bride's, in which a chip was lodged in the tissue of the iris for seven or more years, causing no change other than repeated attacks of iritis.

If a chip has penetrated the eye and is completely embedded in the sclera, no siderosis is likely to appear. The crystalline lens is tolerant of a foreign body, and certainly iron or steel may remain in it for a long time without diffusion of metallic particles.

Siderosis may arise from iron or steel in the vitreous, retina, ciliary body and choroid.

That siderosis is a rare condition is evidenced by the fact that among 458,496 patients admitted to the Royal Eye Hospital during fifteen years ending 1913, only thirteen had been diagnosed as siderosis. This number is somewhat short of the actual total, as others were diagnosed after they had been admitted into the hospital.

The clinical appearance consists chiefly in a rusty-brown discoloration of the iris, opaque lens which often presents a yellowish-brown tinge; the characteristic marks, however, are the deeper-brown opacities toward the periphery in the subcortical zone. Such an eye may be quiet, or may show signs of uveitis in any degree of severity.



Ring of Dots on the Anterior Capsule of the Lens in Siderosis Bulbi (Lockhart Gibson.)

The particulars in the cases reported are given. The last case is particularly interesting in that a small foreign body entered the periphery of each cornea down and out, without wounding the lens, each eye revealing a definite scar at the back. Siderosis appeared in each. In the left eye such violent inflammatory changes took place about eighteen months after the entrance of the foreign body that the eye had to be removed. The second eye had tolerated the presence of a chip of iron for nineteen years, and in it the amount of siderosis was not great; the difference probably being that in the right eye the fragment was entirely embedded in the sclera, whereas in the left it probably projected through the choroid into the vitreous.

Lockhart Gibson (*Med. Journ. of Australia,* p. 201, Sept. 7, 1918) records two cases of siderosis bulbi the result of war wounds. In one, examination of the left (injured) eye showed the iris to be of a rich yellowish-brown color, the pupil semi-dilated, the aqueous somewhat

turbid, no macroscopic opacities in the media. A large patch of denuded sclera was noticed in the lower fundus areas. The X-ray showed a foreign body behind the lens in the lower fundus, i. e., near the wound in the sclera. The fragment of iron was removed and vision remained as before the operation. The figure represents the ring of siderotic dots on the anterior surface of the lens in this case.

Siderosis of the eyelids. This shows itself as small brown spots.

Siderosis of the conjunctiva. It is said that (apart from the ordinary iron staining of the conjunctiva) a yellow discoloration of this tissue may follow prolonged use of iron sulphate.

Siderosis of the cornea. As stated, in this condition opaque spots of a rust-brown color form in the cornea. Ball has observed one such case of corneal staining due to the lodgment of a piece of steel in the lens.

Siderosis of the lens ciliary body and retina. Red material (Parson's *Pathology of the eye*, p. 1177) is occasionally deposited in the lens, generally as a circle of oval patches arranged concentrically with the margin of the dilated pupil. Bunge proved that this appearance is due to iron stains and not to hemorrhage. Brown granules were found in the corneal corpuscles, in the meshes of the ligamentum pectinatum, on the inner surface of the ciliary muscle, and in the retina. Perls' microchemical reaction just described showed the whole retinal vascular system marked out by blue coloration.

Siderostat. A heliostat regulated to siderial time.

Siderostatic telescope. A fixed telescope used for astronomical observations by the aid of a siderostatic mirror.

Side-transit. A transit instrument having the eyepiece in the horizontal axis and provided with a reflecting prism.

Siebbeinerkrankungen. (G.) Diseases of the ethmoid.

Siebbrille. (G.) Stenopaic glasses.

Siebold, Barthel von. Son of Karl Kaspar Siebold, and himself a surgeon and ophthalmologist of some importance. From 1802 till 1814 he lectured on ophthalmology at Würzburg.—(T. H. S.)

Siebold, Karl Kaspar von. A distinguished German surgeon and obstetrician, father of Barthel von S., and an ophthalmologist of some importance. Born Mar. 19, 1801, at Würzburg, Germany, the son of the celebrated obstetrician Adam Elias von Siebold, he became in 1769 professor of anatomy, surgery, and obstetrics at the University of Würzburg, and, while acting in this capacity, gave regular courses of lectures on ophthalmology for a number of years. In 1833 he was called to the chair of obstetrics at Göttingen—a position which he held until his death, Oct. 27, 1861.—(T. H. S.)

Siegrist's method of local anesthesia. This consists of the intraorbital

injection of novocain (see p. 8384, Vol. XI of this *Encyclopedia*) and adrenalin in ophthalmic operations.

Sight. (a) The ability to perceive objects by means of the eyes. (b) Scope of vision; limits of visual perception.

Sight, Day-. Nyctalopia, or night-blindness.

Sight, Far. Hypermetropia.

Sight, Near. Same as myopia.

Sight, Night-. Hemeralopia, or day-blindness.

Sight, Old. A common name for presbyopia.

Sight, Second. In ophthalmology this term is applied to the development of myopia (often as high as four or five diopters) through swelling of the lens in incipient cataract. See p. 1502, Vol. II of this *Encyclopedia.*

The vulgar meaning of the term has to do with a form of *clairvoyance.* See p. 2285, Vol. III. As John Cameron indicates (*Canadian Med. Journ.*, p. 405, May, 1916), this is one of the extraordinary beliefs that pervades the Keltic mind. A person of normal mentality would suddenly call out, "Oh, Mr. So and So has had an accident," or "Mr. So and So is dead," and sure enough, at that very moment the individual named would be found to have suffered the injury described, or have died. On questioning the person who had this sudden inspiration, he would usually answer: "It suddenly came into my head." The following is another manifestation. An individual would suddenly see a person, whom he knew and recognized moving towards or away from him, shrunk to half his normal height, and then just as suddenly vanish into thin air. This is always looked upon as a foreboding of evil, for the person seen would be found to have died at the time the apparition appeared. This unpleasant experience has usually been attributed by sceptics to a rather free indulgence in the "normal" beverage, but in reply to that accusation, it may be said, that the usual effect of alcohol in immoderate doses is not to shrink the size of the person observed but rather to reproduce him in duplicate.

Sight, Short-. A vulgar name for defective near vision, usually myopia.

Sight-vane. A metal leaf having a pin-hole or slit-sight in it.

Signa. Latin for *mark* or *write*: abbreviated to *s.* or *sig.* on prescriptions. See **Signature.**

Sign, Abadie's. Spasm of the levator palpebræ superioris muscle, a sign of exophthalmic goiter; also, insensibility of the Achilles tendon to pressure; seen in locomotor ataxia. See p. 19, Vol. I of this *Encyclopedia.*

Signaling. The necessity of some method of rapidly conveying orders

or intelligence to a distance in naval life was early recognized. In fact, Polybius describes two methods in use, three centuries before Christ, and also one that he invented himself. The signal codes of the ancients were very elaborate, and generally some kind of a flag was used. Shields displayed in a preconcerted way so that the sun's rays struck them, were the progenitors of the modern heliograph. In the middle ages, banners and lanterns were used to distinguish certain fleets, and also officers of certain ranks, as well as to report sighting an enemy. By the middle of the 14th century reports of guns, fires and lights were known to have been used for night work, and flags for day. The signification depended on the position the flag or light was held or displayed. Orders then were communicated by boats or by hailing, the use of the trumpet being known. But as the size of ships increased, attempts at regular codes were made, and the first to whom credit is given for inventing such a code that was practicable was James II, then Duke of York. But all signaling was imperfect until the middle or latter part of the 18th century, when a plan of signaling was devised which was the parent of that now used. About 1858 the Colcomb system was introduced, and after it was learned thoroughly by the British navy it was made possible to handle with safety in darkness or fog the fleets of the largest ironclads. But it was not until (1861) General Myers (Albert), the first chief signal officer of the United States Army, devised his system, that the United States fleets and armies had a system so perfect that it not only superseded all others, but brought many victories to the Federal forces, and finally was adopted generally by all civilized countries. All signals now are by sight or sound and can be seen or heard beyond the voice or power of the eyes. Steam whistles, semaphores, flashing, fire-works, lanterns and flags are all used, as well as the telephone and telegraph. In the United States navy the French Ardois system of colored lights or lanterns is used for night work. The army signal system of heliograph and flag is used for day work. The telephone is used at all times. There is no special corps of signalmen as in the army, but every ship has a few selected men and officers who are told off for signal duty, and highly drilled in sending and receiving messages by flag or lantern. A system of flag signals and a code for it are kept on board each ship, and are under strict guard at all times. For distant signals, flags are always used in day work, but the code books of the army and navy both contain certain abbreviations for whole sentences and phrases.—(*Standard Encyclopedia*).

Signalman, The eyes of the. In addition to the observations made elsewhere (see **Eyes of Sailors, et al.**; as well as **Sailors, Eyes of**)

Alexander Duane (*Am. Journ. Ophthalm.,* p. 555, Aug., 1919) gives the results of his two years' experience in charge of the signal bridge on the U. S. S. Granite State. During this time he tested practically the ability of two hundred men in *making and reading signals.* A hundred of these served on the bridge under his direct supervision, so that he was able to study the behavior of their eyes under active service conditions.

The exacting conditions under which the marine and naval signalman does his work, and the mental and physical alertness required, as well as a description of the various types of signalling used in the American, British and other foreign navies are set forth by Duane. As a result of this study the writer concludes: 1. The visibility and legibility of our signal and other flags could be much improved if the blues were made much lighter, the reds were made somewhat lighter, and care was always taken not to make the yellows too light. It would also be better if the pennants had a rounded or obtuse, instead of a finely tapering tip, as this part of the flag becomes hard to read in proportion as it tapers down. 2. The ocular requirements that we should lay down for a candidate for signal work should always be considered in connection with his other physical and mental qualifications and to a certain extent should vary with these. "A like correlation," he adds, "between the strictly physical qualifications and the general mental and moral make-up of the candidate should, I believe, be made in the case of all candidates for military and civil positions. This is done now to some extent, but the principle might be extended with advantage. As I have elsewhere remarked, this correlation is best effected if the medical officer who makes the physical tests and the professional expert, who gauges the probable availability of the candidate from a technical standpoint, work hand in hand." 3. In making such a correlation, we must distinguish between the visual requirements, which, being indispensable for the purpose in hand are necessarily inflexible, and those in which more latitude may be allowed. 4. For signalling the ideal visual requirements are: Visual acuity of 20/20 in each eye without correction; perfect color-sense; first-rate light-sense and quick adaptation; orthophoria for distance and near, with good converging, and especially with good diverging, power; quick reaction time. 5. Of these requirements three are indispensable, viz., perfect color-sense, first-rate light-sense, and quick reaction time. Coupled with these there must be a good all-round physical condition.

Duane continues: "6. To test these matters out in a practical way, I would first take each applicant's vision; examine his color-sense

with the lantern and with other tests, of which, I think, the most available are Nagel's and Stilling's; if a photometer could be had, I should measure his light-sense with it, and, if I had no photometer, would test out the light-sense by making the applicant pick up faint distant objects under difficult visual conditions; I would apply some simple psychologic tests to ascertain his reaction time and quickness in making mental discriminations; and would determine his muscle balance for distance and near and his converging and diverging power. Those who showed deficiency in color-sense or light-sense, were markedly slow in their reactions, or were evidently below par in their physical and mental vigor, I would reject at once. The rest I would place in a signal class, conducted at first below decks, later on the upper deck and on the bridge. 7. Of the men so placed, I would put those with subnormal vision or abnormal motility in a probationary class. While they were in this I would ascertain the cause of their deficient sight, and if it was due to a refractive error would correct it. 8. Those of the signal class who displayed marked enthusiasm and readiness in learning, and steadiness and reliability in their work, coupled with the ability to discern far distant signals or objects under all sorts of service conditions (especially when the contrasts were poor), I would admit to permanent service on the bridge even if their visual acuity was not up to the full standard. I should even think it proper in the case of specially good men to take them on even if their ametropia was such that uncorrected vision was 20/40 or less, so that they could not see distant objects by any means as well without their glasses as with them. Such men, of course, would have to do their work on the bridge with glasses, which, after all, are only a relative handicap. On the other hand, no matter how perfect his vision was and no matter how technically well-fitted he seemed, I would not have a man on the bridge who showed in the preliminary work in the signal class that he was erratic or quarrelsome, or who did his duties carelessly, perfunctorily, or reluctantly, or who was unreliable. In fine, my idea is that the initial physical examination should be more or less elastic and tentative, eliminating simply those who are absolutely unfit, but admitting to further trial under service conditions all the other applicants, whether visually below standard or not; and that when this further trial has disclosed what each man's visual, mental, and moral qualifications are, the signal officer with, if necessary, the aid of the surgeon shall determine which of the men under investigation are fit for duty on the bridge."

Signals, Danger. *Popular Mechanics* for February, 1914, says: A colored danger signal consisting of a blue circle placed within a yellow

rim is being advocated for use in industrial plants. Although *red is now almost universally used as a danger signal,* it is far from satisfactory for that purpose, since of the 4 per cent. of all men who are defective in color perception the majority are unable to distinguish red. Yellow and blue are the most luminous colors of the spectrum, and a combination of these colors can be seen at a greater distance in daylight and is more easily distinguishable in poor light than any single primary color or any other combination of colors. In addition to this it has been found by experiment that this combination appears as red or green to workmen who are unable to distinguish yellow and blue, so that a definite danger indication is given in any case.

C. P. Small has made the following comments on this new form of danger signal. The note was published in the *Journal of the American Medical Association,* January 17, 1914, and reads as follows: "On a purely scientific basis we can explain why blue and yellow would be extremely poor substitutes for green and red. Ordinary blue glass transmits many red rays besides the blue ones, leaving about 4 per cent. of the naked light behind it to pass through it; while by a glass of fairly pure blue, the luminosity would be reduced to about 2 per cent. This luminosity in foggy weather would be reduced to nothing. A yellow signal would be luminous enough, but under certain atmospheric conditions would appear too much like white. Green transmits from 10 to 20 per cent. of the luminosity of the light behind it, while red glass also allows about 10 per cent. of the light behind it to pass through. In our days of high speed, both on land and on sea, it is highly necessary to be able to see and distinguish the colors of light at a distance of several thousand feet. In certain conditions of the atmosphere, blue and yellow cannot be distinguished as such at this distance, and the danger of collisions would be greatly increased if these colors were to be used as signals. The important thing to be considered is this: the main object is not to use colors which will be most easily distinguished by the comparatively small number of color-blind persons (less than 4 per cent. of the entire population) under the most favorable conditions, but to use such colors as will be most easily seen by the 96 per cent. of normal-sighted persons under the most favorable conditions. This matter is, in fact, only a more conclusive argument for prohibiting color-blind persons from holding any position in which a quick and accurate perception of color is an imperative necessity." See, also, p. 3744, Vol. V of this *Encyclopedia.*

Signals, Invisible. Such signals were used in the recent war, owing to the inventive skill of an American, Prof. R. W. Wood, of Johns Hopkins University, whose work with invisible rays, especially in photog-

raphy, has been noted from time to time. Wood's plan is to use a source of invisible rays, either those below or above the visible spectrum, and to employ a receiving instrument that makes them visible again. No one not provided with the proper receiver could have any idea that signals of any kind were passing. The *Literary Digest* (p. 26, Aug. 16, 1919) translates, in part, an account of Wood's apparatus, contributed to *La Nature* (Paris, May 31), by H. Vigneron. First, Wood perfected the classic devices of optical telegraphy. In one of the systems in service in the German Army the signals are made by an electric lamp placed inside a tube which enables the sender to direct the light-beam as he chooses. Field-glasses fitted with this system enables a soldier to observe the signals sent in reply. The batteries supplying the lamp are placed in the belt. All the apparatus of optical telegraphy are based on the same principle. The improvement introduced by Wood consists in increasing the precision of the transmitting instrument so that the size of the light-beam may be greatly diminished and secrecy thus insured, the signal being visible only at the receiving-station.

"The device consists of an achromatic lens at whose focus is a nitrogen-filled, metal-filament lamp operated by a battery of five dry piles and fitted with an ordinary Morse key. Behind the lamp is an eyepiece through which the receiving-station is exactly visible.

"When the sender looks through the eyepiece he sees the image of the lamp-filament projected against the landscape and is able to hold the device so that this image falls precisely on the receiving-station. * * *

"With this apparatus and the nitrogen lamp, communication may be maintained up to distances of eighteen or twenty miles, the diameter of the light-beam at one and one-quarter miles not exceeding six feet. The weak point of this method may be seen at once: if the trenches are very near it is impossible to communicate with the receiving-station without the enemy's also getting the signals. The system, therefore, had to be modified. Wood did this by using invisible light-rays for the signals. It is well known that under this general term are included infra-red and ultra-violet rays.

"If we place before the lamp a screen that allows only these infra-red rays to pass * * * these will not be perceived directly by the eye; but if at the receiving-post a similar device be used the observer will see the black field of his glass illuminated in red. Owing to this arrangement, secrecy is assured and the device may be used in this way at distances of five to six miles.

"To utilize the ultra-violet ray—and this is the most original feature

of Wood's inventions—this scientist has succeeded in making a kind of glass absolutely opaque to the visible rays, but perfectly transparent to the ultra-violet. This glass, composed of silicate of soda and nickel oxid, therefore looks opaque to the eye, and to observe the rays that pass through it a detector is necessary. Wood utilizes the fluorescence of some such substance as platinocyanid of barium. In these conditions the range is five to six miles.''

For marine signaling, where a greater range is necessary, Wood, we are told, increases the intensity of the ultra-violet ray by using an ordinary mercury vapor-lamp surrounded by a screen of the special glass just described. If a ship carries two invisible signals of this sort at a standard distance apart, the observer, looking through his detector, can tell how far away she is. To quote further:

''At the entrance of a port, in a channel, if the buoys are painted with a fluorescent substance and the ship is supplied with a projector of ultra-violet rays, when the invisible beam strikes the buoy it will shine out clearly.

''To facilitate the landing of airplanes and the marking of aviation-fields, the ultra-violet rays may be similarly used. The aviator seeking to land examines the ground with a glass having a fluorescent screen and finds his field by its fixed ultra-violet signals.

''Wood's investigations, although made for military purposes, have produced results that will be more generally useful; for they give us full control of the ultra-violet rays as a source of energy.''

Sign, Aschner. See **Oculocardiac reflex,** p. 8470, Vol. XI of this *Encyclopedia.*

Signature. 1. That part of a prescription which gives directions as to the taking of the medicine. 2. Any characteristic feature of a substance formerly regarded as an indication of its medicinal virtues: thus, the eye-like mark on the flower of the *euphrasia* (q. v.) was supposed to show its usefulness in eye diseases; the liver-like shape of the leaf of *liverwort* pointed to its use in hepatic diseases; the yellow color *saffron* indicated its use in jaundice, etc.

Signature de la verole. (F.) The indicator of syphilis. A term applied by Fournier and Ricord to the oculomotor or third nerve, on account of its frequent involvement in lues, especially in (syphilitic) tabes and paresis.

Sign, Babinski's. Diminution or absence of the Achilles tendon reflex in true sciatica as distinguished from hysteric sciatica.

Sign, Ballet's. Ophthalmoplegia externa (with loss of all voluntary eye movements), the pupil movements and automatic eye movements persisting: seen in exophthalmic goiter and hysteria.

Sign, Bard's. A test to differentiate between organic and congenital nystagmus. In the former the oscillations of the eyeball increase when the patient follows the physician's finger moved before his eye alternately from right to left, and from left to right. In the latter the oscillations disappear under these conditions.

Sign, Becker's. Spontaneous pulsation of the retinal arteries in exophthalmic goiter.

Sign, Berger's. An irregular-shaped or elliptic pupil in the early stages of tabes dorsalis, paralytic dementia, and certain paralyses.

Sign, Bjerrum's. The formation of a ring-shaped scotoma, developing often in intracranial tumor, about the blind spot. Szily (*Klin. Monatsbl. f. Augenheilk.*, Feb., 1913), believes this sign can be accepted as a symptom of choked disc threatening grave results and an indication for further operative interference. He also points out that Bjerrum's sign is likewise found in nonglaucomatous eyes. See, also, **Ring scotoma.**

Sign, Bordier-Fränkel's. An outward and upward rolling of the eye in peripheral facial paralysis.

Sign, Boston's. In exophthalmic goiter, when the eyeball is turned downward there is arrest of descent of the lid, then spasm, then continued descent.

Sign, Charcot's. Signe du sourcil. In facial paralysis the eyebrow is raised; in contracture of the facial muscles it is lowered.

Sign, Cinema. P. Sainton (*Monde Médicale*, p. 108, April, 1917) points out the fact that (cranial) trephined subjects are almost invariably unable to enjoy a cinema entertainment. Out of 27 subjects whom he discreetly questioned from this point of view, 24 manifested the greatest dislike for this kind of spectacle which caused them very distressing sensations. In the course of a few minutes they are obliged to leave on account of the dazzling, the giddiness and the headache thus caused.

The information thus obtained is interesting in respect of the men's future life. For example, many a trephined (soldier) subject who at the depot lives an apparently normal life, is seized at the firing line with vertigo and headache under the influence of the bombardment. Some indeed are subject to nervous attacks when called upon to practice at the butts. These are data which should be known to every one for they show that the trephined subject is not always as normal as he looks. The next question is whether these subjective disturbances are not dependent upon hidden lesions, possibly amenable to treatment.

Sign, Crichton-Browne's. A tremor of the outer angles of the eyes and

of the labial commissures in the earlier stages of paretic dementia.

Sign, Dalrymple's. Abnormal wideness of the palpebral opening in exophthalmic goitre.

Sign, Davidsohn's. The normal reflection of light through the pupil in transillumination.

Sign, Gifford's. Inability to evert or great difficulty in everting the upper lid; seen in exophthalmic goitre.

Sign, Gould's bowed-head. In retinitis pigmentosa or other disease destroying the peripheral portion of the retina, the patient often bows the head low to see the pavement, in order to bring the image upon the functional portion of the retina.

Sign, Gowers'. Abrupt intermittent oscillation of the iris under the influence of light; seen in certain stages of tabes dorsalis.

Sign, Graefe's. Failure of the eyeball to move downward with the upper lid in looking downward. See **Exophthalmic goitre,** p. 4806, Vol. VI of this *Encyclopedia.*

Sign, Hutchinson's. Interstitial keratitis and a dull-red discoloration of the cornea in inherited syphilis. *Hutchinson's trio;* interstitial keratitis, notched teeth and otitis media occurring together in inherited syphilis.

Sign, Joffroy's. Absence of facial contraction of exophthalmic goitre when the patient suddenly turns his eye upward.

Sign, Kennedy's. See p. 6742, Vol. IX of this *Encyclopedia.*

Sign, Kocher's. See **Symptom, Kocher's.**

Sign, Liebreich's. See **Symptom, Liebreich's.**

Sign, Löwy's. Marked dilatation of the pupil on the instillation of adrenalin into the conjunctival sac; seen in pancreatic insufficiency.

Sign, Magendie-Hertwig's. Deviation of that eye in which one eye is directed higher than the other; a hyperexotropia.

Sign, Marie's. Tremor of the body or extremities in exophthalmic goitre.

Sign, Möbius'. Inability to keep the eyeballs converged in exophthalmic goitre, due to insufficiency of the internal recti muscles.

Sign, Oculocardiac. See **Oculocardiac reflex,** p. 8470, Vol. XI of this *Encyclopedia.*

Sign, Orbicularis. In hemiplegia, inability to close the eye on the paralyzed side without closing the other.

Sign, Parrot's. Dilatation of the pupil on pinching the skin of the neck: seen in meningitis.

Sign, Prevost's. In hemiplegia, conjugate deviation of the head and eyes, the eyes looking toward the affected hemisphere and away from the palsied extremities.

Sign, Pseudo-Graefe. Slow descent of the upper lid on looking down, and quick ascent on looking up; seen in conditions other than exophthalmic goitre.

Sign, Raab's. Raab's pupil reflex. See p. 1971, Vol. III of this *Encyclopedia.*

Sign, Revilliod's. Inability to close the eye on the affected side in paralysis of the superior facial nerve.

Sign, Ripault's. External pressure upon the eye during life causes only a temporary change in the normal roundness of the pupil; but after death the change so caused may be permanent.

Sign, Rochester's. See **Rochester's sign,** p. 926, Vol. II, of this *Encyclopedia.*

Sign, Romberg's. Swaying of the body when standing with the feet close together and the eyes closed; a sign of locomotor ataxia.

Sign, Rosenbach's. (1) Tremor of the eyelids in exophthalmic goitre. (2) Also, inability to close the eyes immediately on command: seen in neurasthenia. See **Rosenbach's phenomenon.**

Sign, Rothschild's. (1) Preternatural flattening and mobility of the sternal angle: seen in phthisis. (2) Rarefaction of the outer third of the eyebrows in thyroid inadequacy.

Sign, Sænger's. A light reflex of the pupil that has ceased returns after a short stay in the dark; noticed in cerebral syphilis, but not in tabes dorsalis.

Signs and abbreviations used in ophthalmology. A. or Acc., Accommodation; Am., ametropia; As., astigmatism, astigmatic; As. H., hypermetropic astigmatism; As. M., myopic astigmatism; Ax., axis (of cylindric lens); B., base (of prism); C. or Cyl., cylindric lens or cylinder; cm., centimetre; Cr., centrads; D., dioptre; E., emmetropia or emmetropic; F., field of vision; H., hypermetropia, hypermetropic, horizontal; Ha., axial hypermetropia; Hc., curvature hypermetropia; Hi., index hypermetropia; Hl., hypermetropia latent; Hm., hypermetropia manifest; Ht., hypermetropia total; L. or L. E., left eye; M., myopia or myopic; Ma., axial myopia; Mc., curvature myopia; Mi., index myopia; m., metre; M. A., metre angle; mm., millimetre; n., nasal; O. D. (R. or R. E.), oculus dexter (right eye); O. S. (L. or L. E.), oculus sinister (left eye); O. U., oculus uterque (both eyes); Oph., ophthalmoscope or ophthalmoscopic; P. L., perception of light; P. p., punctum proximum (near point); P. r., punctum remotum (far point); Pr., presbyopia; R. or R. E., right eye; S. or Sph., spheric lens; t., temporal; T., tension; V., vision, visual acuteness, vertical; w., with; +, plus or convex; —, minus or concave; =, equal to; $\frown$, combined with; 8, infinity (20 feet or more distant); ′, foot; ″, inch;

‴, line; °, degree (prism); △, centrad (prism); △, prism-dioptre.

The following signs are useful in recording the state of the ocular-muscle balance:

Orth., orthophoria, or proper balance in all directions; =, proper lateral balance; < or Ex., exophoria, less than normal convergence, tendency to divergence; > or Eso., esophoria, more than normal tendency to convergence; | |, vertical balance; ∨, Rt. Hyperph., right hyperphoria, or tendency of the right eye to turn above the left; ∧, Lt. Hyperph., left hyperphoria, or tendency of the left eye to turn above the right.—(J. M. B.)

Sign, Seeligmüller's. Mydriasis on the side of the face affected by neuralgia.

Sign, Seidel's. Wing-like extensions of the blind spot, the concavities facing the fixation point Seidel (Graefe's *Archiv für Ophthalm.*, 88, p. 102, 1914) claims that these scotomata may be found in eyes that are apparently healthy but that later on develop glaucoma. Later the Seidel sign develops or passes into Bjerrum's sign with its much greater enlargement of Mariotte's spot.

Sign, Skeer's. A small circle in the iris, near the pupil of both eyes; seen in tuberculous meningitis.

Sign, Snellen's. In exophthalmic goitre. See **Snellen's sign.**

Sign, Stellwag's. An apparent widening of the palpebral opening in exophthalmic goitre.

Sign, Tay's. The cherry-red spot about the fovea. See p. 4288, Vol. VI of this *Encyclopedia.*

Sign, Tellais'. Pigmentation of the eyelid in exophthalmic goiter.

Sign, Uhthoff's. Nystagmus occurring in multiple cerebrospinal sclerosis.

Sign, Vigouroux's. Diminished electric resistance of the skin in exophthalmic goiter.

Sign, Vincent's. A synonym of the Argyll Robertson pupil (q. v.).

Sign, Weber's. See **Weber's symptom.**

Sign, Wernicke's. The hemiopic pupillary reaction. See p. 5775, Vol. VIII of this *Encyclopedia.*

Sign, Westphal's. See **Westphal's sign,** p. 2473, Vol. IV of this *Encyclopedia.*

Sigwart, Georg. A well-known Tübinger ophthalmologist, who was born at Gross-Bettlingen, Würtemberg, April 8, 1711, and who died at Tübingen, Mar. 9, 1795. He studied at first theology, passed his theological examinations, and taught theology for four years. Turning his attention to medicine, he studied at Leipsic and Halle, at the latter institution receiving his degree in 1742. He soon became pro-

fessor of anatomy and surgery at Tübingen, and also an ophthalmologist of international reputation. He never wrote a book, but published a large number of dissertations: According to Hirsch, 55; and according to Hirschberg, 77. His most important work, in the view of the latter authority, is "Novum Problema Chirurgicum de Extractione Cataractae ultra Perficienda."—(T. H. S.)

Silberol. A proprietary sulphocarbolate of silver, used in gonorrhea and in purulent eye inflammations.

Silcock, Arthur Quarry. A well-known London general practitioner and ophthalmologist, one of the last of distinguished physicians to adhere to the combination of a specialty with general practice. He was born in 1855, became surgeon both at St. Mary's Hospital and at Moorfields, and died of appendicitis at his residence in Harley Street, London, Dec. 19, 1904.—(T. H. S.)

Silcox's ointment. A preparation of mercuro-zinc cyanide (used chiefly for infectious conjunctivitis and similar conditions in the proportion of 1-5,000 to 20,000). The Moorfield's *Pharmacopeia* gives a salve containing one or two per cent. of the double salt in soft paraffin for use in burns of the lids and for granular lids. This ointment is known in the Royal London Ophthalmic Hospital as Silcox's ointment. See p. 7648, Vol. X of this *Encyclopedia*.

Silex's test for feigned blindness. This observer has modified the well-known Arlt device (q. v.) by placing a series of plane or very weak concave lenses (without regular order) before the sound eye. As is well known, the normal eye can by means of a six-diopter convex lens be rendered artificially myopic, thus making it unable to read small letters farther away than about seventeen centimetres. The patient (before whose sound eye the 6 D. lens is finally placed) is asked to read at a short distance and the distance of the test-types is gradually increased appreciably *beyond* seventeen centimetres. If the ability for reading continues to be possible from seventeen centimetres on, it can only be done with the eye that has been declared to be defective. In this experiment, as in the preceding, it is easy to convict the patient of his trickery at once by asking him to continue reading after the sound eye has been closed.

Silhouette. A profile or shadow outline filled in of a dark color, the shadows and extreme depths being sometimes indicated by the heightening effect of gum or some other shining material. This species of design was known among the ancients, and was by them carried to a high degree of perfection, as the monochromes on Etruscan vases amply testify; but the name silhouette is quite modern, dating from about the middle of the 18th century, tho the art itself seems to

have been practised in England prior to 1745. It was taken from Etienne de Silhouette (1709-67), the French minister of finance for four months in 1759. Thus profiles made by tracing the shadow projected by the light of a candle on a sheet of white paper, the rest of the figure being filled up in black, have continued to bear the name. Altho without merit as a work of art, the silhouette presents a clear and well-marked profile.—(*Standard Encyclopedia*).

Siliculose cataract. SILIQUOSE CATARACT. See p. 1746, Vol. IV of this *Encyclopedia.*

Silkworm gut consists of the drawn-out glands of the silkworm at the time it is about to spin its cocoon and when these glands are fully distended. The worms are immersed for twelve or fourteen hours in strong vinegar, and then taken separately and pulled asunder. The skilled operator knows by the strength of the silk-gut if the soaking in vinegar has been sufficient, and if so he lays hold of the ends of the two silk-glands and draws them out gently to the proper length —and so the gut is formed. This preparation is admirably adapted to ophthalmic operations. (See **Sutures.**)

Sillonneur. (F.) A three-bladed scalpel for operations on the eye. See **Trachoma.**

Silva, W. H. de. A well-known Cingalese ophthalmologist. Born in 1868, a descendant of one of the older houses of the historic Lindamullaga clan, he studied at the Prince of Wales College in Moratuwa and at St. Thomas' College, Columbo. He next proceeded to England, where he completed his medical studies at Mareschal College, Aberdeen, and, in ophthalmology, at the Royal Eye Hospital, in London, and with Galezowski, in Paris. Returning to his native country, he became prominent as an ophthalmologist and as a public spirited citizen, and was one of the founders of the Queen Victoria Eye Hospital.

He is said to have died of choleraic diarrhea, the result of eating caju-nuts, Apr. 3, 1908.—(T. H. S.)

Silver. SILVER SALTS IN GENERAL. ARGENTIC COMPOUNDS. The remarks made by the Editor some years ago (*System of Ophthalmic Therapeutics*, p. 542) on this subject seem to him still to be substantially true.

The salts of silver have long been regarded as among the most useful of our therapeutic agents and their popularity is shown by the embarrassing number of argentic compounds put on the market in recent years. The Editor has endeavored to treat most of these—and their name is legion—on their merits, both individually and collectively, and to that end has experimented with each as they were

accessible. Speaking generally he is quite of the opinion that where an argentic compound is urgently needed, as in ophthalmia neonatorum, adult gonorrheal conjunctivitis and the other blennorrheas there is no substitute for the nitrate. Valuable as are argyrol and other mild preparations, he still believes that in efficacy they are inferior to the older preparation.

In addition to the nitrate numerous other (mostly metallic) salts of silver have been recommended in ophthalmology; for example, the acetate, benzoate, borate, cinnamate, citrate, eosolate, iodate, iodide, lactate, oxide, permanganate, phenolsulphonate, salicylate, sulphate and tartrate. Several of these, as well as others not included in this list, will be found considered under separate captions, here and elsewhere in this *Encyclopedia*.

In this connection the British Medical Association report of Marshall and Neave (*British Med. Journ.,* Aug. 18, 1905) on a few of the marketed silver-salts as compared with the nitrate is of great interest. First, the percentage of metallic silver was found in each remedy as follows: Collargol, 88.6; silver fluoride, 81.7; silver nitrate, 63.6; itrol, 60.8; actol, 51.5; argentol, 31.2; ichthargan, 27.1; argyrol, 20.0; albargin, 13.4; nargol, 9.6; largin, 9.4; novargan, 7.9; protargol, 7.4; argentamine, 6.4; argonin, 3.8.

These results were used in preparing the various solutions. Each solution was made to contain a definite percentage of silver. This appeared to be the only method available for comparison, as equimolecular solutions could not be employed owing to the composition of many of the substances being unknown.

The results are given as obtained with a mixed culture and with a pure culture of staphylococcus pyogenes aureus. The antiseptic action was determined by observing the time taken by minced, cooked beef to putrefy in the presence of solutions of silver compounds of known strength, and by inoculating an agar mixture.

The experiments showed that as regards bactericidal action the various silver compounds investigated fall into three groups: (1) Those which are powerful bactericidal; (2) one—nargol—much less powerfully bactericidal; (3) two—argyrol and collargol—which possess practically no bactericidal action whatever.

The first group includes most of the substances investigated, namely, silver nitrate, silver fluoride, actol, itrol, argentamin, argentol, albargin, argonin, ichthargan, largin, novargan and protargol. The bactericidal action of these, in solutions containing the same percentage of combined silver, is closely similar, and it is practically impossible to place them in any order of activity which would be true under all circumstances.

See, also, **Ophthalmia neonatorum,** p. 8511, Vol. XI; as well as **Argyrosis oculi,** p. 575, Vol. I of this *Encyclopedia.*

The *Ophthalmic Year-Book* for 1909 has a number of observations on the general use of silver salts in ophthalmology. To diminish the pain caused by applications of silver nitrate to the eye, Harman adds 15 per cent. of glycerin. He believes this also increases the penetrating power of the solution. Gliozenis limits, to not over 3 per cent., the strength for silver nitrate solution. In the matter of choosing the best salt of silver for use in a particular condition, Oliveres advises the use of organic salts, if the secretion be not purulent. For purulent conjunctival discharge he thinks cauterization by silver nitrate cannot be replaced by any other medication. Derby believes that the silver nitrate is the only salt that should be used outside of a hospital, either at the office of the surgeon or the home of the patient. The good results reported from hospital treatment under the organic silver salts he ascribes largely to the continual cleansing, efficiently carried out. Pawlow has largely replaced silver nitrate by collargol, and Sokolowsky reports favorably an experience with it in 42 cases, including infections of the different tissues of the eyeball. Guersich has had a similar experience in eight cases of severe purulent infection, trachomatous pannus, parenchymatous keratitis, and wounds of cornea and sclera. Either the salve or a 2 to 5 per cent. watery solution may be employed. The latter may be used for conjunctival injections or instillations into the conjunctiva.

Bock reports upon the formonucleinic compound of silver, *sophol,* containing 20 per cent. of silver, in the treatment of various forms of conjunctivitis. He applies it in a 5 per cent. solution to the everted lids. In ophthalmia neonatorum it is inferior to silver nitrate, but its application causes no pain. It is of considerable service in phlyctenular disease; and acute catarrh is speedily subdued by it, the discharge, irritation and photophobia being quickly relieved.

From experimental studies Pitzman (*Oph. Year-Book,* p. 45, 1912) concludes the silver preparations represent the widest range of activity, from absolutely nil, through various antiseptic gradations to most powerful germicides, depending on the combination in which the silver exists. He finds there are two classes of silver albuminates. In one no free excess of silver nitrate is present; this includes collargol and argyrol. These are good antiseptics, but poor germicides. The second class contains some free silver nitrate, and they are germicides of varying power; equal in value, but perhaps not superior to diluted solutions of the nitrate. This class includes protargol, ichthargan, albargin, novargan, etc. He thinks preparations of the first class

are not suited to replace silver nitrate in the Credé prophylaxis of ophthalmia neonatorum, which calls for an active germicide. Pitzman warns against placing confidence in conclusions based on experiments with the gonococcus, which is liable to die off in cultures without apparent cause.

Syrgol has been applied by Hegner to the treatment of diseases of the eye, at first to gonococcus infections, and then to dacryocystitis, and to milder forms of conjunctivitis. In the presence of the gonococcus a 5 per cent. solution was instilled two to six times a day, for other forms of conjunctivitis a 2 per cent. solution. A 1 per cent. solution was used to irrigate the lacrimal sac.

Theobald calls attention to the greater frequency of argyria (argyrosis) of the conjunctiva, since the introduction of the organic compounds of silver. Cases are now met with after the silver treatment of acute conditions, which have been of comparatively brief duration. He has seen decided staining after the treatment of gonorrheal conjunctivitis in the adult, and where argyrol was prescribed for mild chronic conjunctivitis. In cases like the latter he believes it would be better not to prescribe the organic silver compounds. His faith in protargol is such that he used it to exclusion of silver nitrate in the treatment of gonorrheal conjunctivitis, both in the infant and in the adult.

Schwarz proposes a new method of decolorizing the conjunctiva in argyrosis. He uses subconjunctival injections of a saturated, a half-saturated, or a 30 per cent. solution of potassium iodid, depending upon the extent of the argyrosis and upon the degree of the subsequent reaction. Only small amounts (3 to 4 minims) are injected over a small area at one time, and the eye is then allowed to recover from the severe reaction. Further injections are carried out until the whole conjunctiva is again restored to its normal color.

Silver acetate. ARGENTIC ACETATE. $C_2H_3O_2Ag$. This salt occurs in minute, white crystals, of a disagreeable, metallic taste, soluble in 100 parts of cold and 15 parts of boiling water; slightly soluble in alcohol. In one per cent. solution, it has been employed with success as a substitute for the nitrate, especially in the prophylactic treatment of ophthalmia neonatorum. In Guthrie's salve (q. v.) and in such mixtures as the following, silver acetate is formed in a greater or less proportion: Argent. nit., 0.4 gm. (gr. vi); Liq. plumbi acet., gtt. iv.; Ungt. paraffini, 8.0 gm. (ʒii).

According to Merck's reports for 1906, Zweifel pointed out years ago the advantages of silver acetate as compared with silver nitrate for the prophylactic treatment of gonorrhea neonatorum; this view

was shared by Scripiades and Bischoff, while Leopold and Dauber held silver nitrate to be the better remedy. J. Thies held that, the two being of equal efficacy, the only possible advantage of one over the other would be due to a greater tendency of one to produce irritant appearances. To settle this matter the author made trials with 2,000 children; after mechanically cleansing the eyes, he placed into the right eye a few drops of a 1 per cent. solution of silver acetate, into the left eye a few drops of the usual 2 per cent. silver nitrate solution. The eyes were then bathed with normal saline solution. He found silver acetate to work better than silver nitrate, although the difference was not great. It has other properties, however, which would appear to make it more suitable to the needs of practice than the nitrate. While the latter is readily soluble in water, and its solutions may gradually become more concentrated by evaporation, silver acetate crystallizes out as soon as a concentration of 1.2:100 is reached. Thus the danger of using too concentrated a solution is entirely precluded with silver acetate. A further advantage of the acetate is said to exist in the fact that in case silver becomes set free from the solution the acetic acid thus liberated is less irritant than the nitric acid set free, under similar circumstances from the nitrate. For prophylactic treatment in midwifery the acetate would thus appear to be preferable to the nitrate of silver.

Seefelder (*Münchener med. Wochenschrift,* No. 10, p. 475, 1907), like Zweifel and Thies, gives silver acetate the preference over silver nitrate in the prophylaxis of gonorrhea neonatorum. In 500 cases in which he used a 1 p. c. solution of silver acetate, he did not observe an irritant effect.

After instilling the silver acetate drops, no injury to the corneal epithelium was observable, the cornea remaining always perfectly clear, shining and transparent. Only in children of 1 to 4 days of age was a slight inflammation of the conjunctiva observed.

Silver-bath. (a) A solution of nitrate of silver used for sensitising photographic surfaces. (b) A vessel for the use of such a solution.

Silver carbonate. Ag_2CO_3. Gawalowski has produced a soluble carbonate of silver which forms a clear, colorless, water solution, having a neutral reaction and containing 0.25 gm. of silver in every 100 c. c. It will keep unchanged for several months if protected from the air, and may be used in place of the nitrate of silver. It is claimed to be non-irritant and to be decidedly astringent and antiseptic. See, also, **Itrol,** p. 6685, Vol. IX of this *Encyclopedia.*

Silver citrate. ITROL. $AgC_6H_5O_7$. A white powder or in acicular crystals, soluble in 4000 parts of water. As a collyrium this prepara-

tion has been used as an antiseptic and astringent eyewater in the proportion of 1 :10000 to 1 :4000 of distilled water. Solutions should always be fresh.

Silver catarrh. The severe reaction, followed by conjunctival hyperemia, bleeding from the conjunctiva and hazy cornea, that sometimes results from the instillation of Credé's prophylactic solution—2 per cent. silver nitrate. Prompt treatment of this condition—cold fomentations and mild antiseptic solutions—promptly relieves the condition.

Silver fluoride. Ag F. When carbonaate or oxide of silver is treated with hydrofluoric acid a very deliquescent, yellowish-white mass remains, which may be evaporated to dryness. The resulting crystalline conglomeration darkens if exposed to light. It is soluble in water, has marked antiseptic properties and is used generally in 1-5,000 aqueous solution, as a substitute for silver nitrate. (See **Silver.**)

Silver, Gelatose. See **Albargin,** p. 203, Vol. I of this *Encyclopedia.*

Silver ichthyloate. ICHTHARGAN. SOLUBLE SILVER SULPHICHTHYOLATE. This compound of ichthyol and silver is said to contain 30 per cent. of the metal and 15 per cent. of sulphur in organic combination. This agent is a brown, amorphous, stable powder with a chocolate-like odor, readily soluble in water, diluted alcohol and glycerin. It is affected by light and is incompatible with the soluble chlorides. For this drug the claim is made that, containing more silver than the other organic silver compounds lately introduced, it has a prior claim to our consideration in prescribing argentic remedies for purulent conjunctivitis, trachoma, etc.—especially where a non-irritating substitute for silver nitrate is desired. See **Ichthargan,** p. 6135, Vol. VIII of this *Encyclopedia.*

Silver iodide. Ag I. A heavy, light-yellow, tasteless powder, unaltered by light if pure, insoluable in water or alcohol.

Silver iodide is rarely used in medicine owing to its extreme insolubility in human fluids or in ordinary menstrua. However, the active agent in the following mixture, a popular collyrium in the treatment of trachoma (q. v.), is silver iodide, produced by the action of potassium iodide on silver nitrate. It occurs, in the mixture, in the form of suspension. (Formula A.) Argenti nitratis., ʒii; Glycerin.; fl. ʒss; Aquæ dest., fl. ʒii. (Formula B.) Pot. iodid, ʒss; Glycerin., fl. ʒi; Aquæ dest., fl. ʒss.

Mix thoroughly three drops of Formula A with 6 drops of Formula B. Instill three or four drops of the mixture on the everted lids every morning. Use separate pipettes for making the mixture and putting it into the eye.

Silver lactate. ACTOL. Ag $C_3H_5O_3+H_2O$. This salt is found as a white powder or as crystals. It is much affected by light and should be kept in amber-colored bottles; and is soluble in 20 parts of cold water.

As an astringent and antiseptic it is employed as a collyrium in the milder forms of conjunctivitis with secretion, in solutions of 1:4000 to 1:2000. The lids may be brushed with stronger solutions, one-half to five per cent., afterwards neutralizing with 5 per cent. sodium chloride. See, also, **Actol,** p. 87, Vol. I of this *Encyclopedia.*

Silver, Metallic. The finely divided metal is employed as a remedy in several forms; e. g., colloidal silver (see **Argentum colloidale,** p. 654, Vol. I of this *Encyclopedia*), and such preparations as *collosol argentum.* This latter remedy is a clear, sherry-like fluid, which contains the metal silver in a state of suspension in extremely fine particles. Laboratory experiments go to show that exposure for six minutes to its action destroys any known microbe.

A. Legge Roe (*British Med. Journ.,* Jan., 16th, 1915) has used the undiluted product for a number of years, and new speaks in the highest possible terms of its effect in practically all the external diseases of the eye. The only reservation he makes, in fact, is in the various forms of conjunctivitis (excepting those due to gonococci), where he has not found the new product to be as efficient as the ordinary remedies. In burns of the conjunctiva or cornea or eyelids he employs a 50 per cent. collosol ointment.

Silver nitrate. LUNAR CAUSTIC. $AgNO_3$. The use of this ancient ophthalmic remedy is mentioned in the text-book of St. Yves (Graefe's *Archiv für Ophthal.,* II., p. 199, 1854). Its employment for this purpose was reviewed by Graefe and it has since continued to be, on the whole, the most reliable astringent-antiseptic we possess.

In the article referred to von Graefe warns the reader that silver nitrate must be judiciously and cautiously used, that a careful diagnosis should be made before its use, its effects should be watched and that the remedy be discontinued, modified or increased in its dose, as the conditions warrant.

In acute cases of conjunctivitis von Graefe applied a two per cent. solution or a "mitigated stick" made by fusing together equal parts of silver and sodium nitrate. These were applied once or oftener and their effects controlled by salt water, in the case of the solid stick, and by simple water irrigation when the solution was instilled. The effect of either application was further increased or diminished by varying the length of time allowed to intervene between it and the use of the water or neutralizing solution.

As an adjunct to this treatment, when edema of the conjunctiva is associated with much muco-purulent discharge, von Graefe advised, immediately after these applications scarification of the swollen mucous membrane. He further advised that the silver application should not be made so long as there were visible any whitish or yellowish-white exudates or areas, the result of previous cauterizations. On the whole a thorough use of the remedy once or twice a day is sufficient. Although he was at first of an opposite opinion von Graefe finally concluded that in blennorrhea conjunctivæ implication of the cornea did not contra-indicate the use of nitrate of silver even in large doses, although he always stood fast to the dictum that it should never be used in diphtheritic conjunctivitis, especially when the false membrane is well formed.

The usual form of applying silver nitrate is the solution, from one-fifth to twenty per cent., although the caustic "stick" (*argenti nitras fusus,* moulded silver nitrate) is employed as an escharotic and occasionally used to burn exuberant granulations from the ocular region. It is needless to say that strong solutions should be applied with great care and only to the everted lids (preferably with a cotton applicator or camel-hair brush) which are afterwards irrigated with a five or ten per cent. salt solution. In spite of the fact that strong solutions (3 to 10 per cent.) of silver nitrate are decidedly irritant and painful it is probable that they are the most reliable antiseptic-astringents we possess, that in profuse mucopurulent conjunctivitis of any variety they ought to be thoroughly but judiciously employed. On the other hand, weak solutions (1-5 to 1 per cent.) possess no advantage over the astringents, especially over the newly-introduced organic compounds of silver, such as argyrol and argentamin. As time passes one may reasonably expect the nitrate to be used in gonococcus ophthalmia and the severer types of pneumococcus and other purulent infections of the conjunctiva, while the milder infections are treated by other remedies.

It must be remembered that the continued use of even weak preparations of silver nitrate, as is the case with soluble argentic salts, may end in staining (argyrosis) of the conjunctiva.

M. H. Bell believes in full doses of silver nitrate in specific and non-specific blennorrhea as soon as the diagnosis of a serious infection is made. Instead of waiting, as some advise, until the purulent discharge has set in he uses it from the very commencement on the supposition that the action of the antiseptic is mainly directed as a germicide against the bacterial invasion and before they have penetrated deeply into the mucous membrane. He has followed this rule

in a number of cases and has not so far noticed a corneal involvement.

John S. Kirkendall much prefers strong solutions and generally uses forty grains to the ounce of distilled water as a single application in all cases of gonorrhea of the conjunctiva, both infantile and adult. Since the adoption of this plan several years ago he has never lost an eye or had a scar of the cornea, although previously both of these accidents occurred. He everts both lids and applies the silver solution thoroughly to the exposed mucosa, afterwards washing it off with a strong salt solution. This is followed by the use of argyrol every hour, cold applications and thorough cleanliness. He is rarely obliged to use the strong silver solution a second time and has never seen an instance of chemosis of the conjunctiva or corneal implication of any kind, following its application.

The irritation, especially burning, smarting and pain set up by the applications of nitrate of silver or, indeed any other of the stronger astringents, may be relieved by bathing the closed eyes with ice-cold water. For this purpose Percy Fridenberg adds to the ice water, a tablespoonful to a pint, the following: Spt. lavendulæ., Spt. camphoræ., Spt. nitri. dulc, aa., 30.00; Spt. odorat. (Cologneus.), 60.00; Spt. vini. gallici, 60.00; Spt. myrciæ ad., 240.00.

C. L. Frey regards as useless the directions to keep solutions of silver nitrate in actinic or dark-glass bottles. He says: "This has only the effect of covering solutions that have decomposed and that ought to be thrown away and in no wise preserves a good solution. Properly made, solution of silver nitrate is no more affected by sunlight than is a bottle of alcohol or distilled water." Nearly twenty years ago he called the attention of Nettleship to this matter. That well-known ophthalmologist repeated the experiments made by Frey and in a letter to him said that he "entirely agreed with his conclusions."

Hirschberg claims that the effect of this very old ophthalmic remedy is due to the formation, with the superficial tissues, of an insoluble silver albuminate, which being thrown off carries with it the bacteria entangled, as it were, in its meshes. His classic rule for the use of silver nitrate may here be quoted: A half per cent. solution for catarrhal conjunctivitis; one per cent. in trachoma and two per cent. for blennorrhea.

In gonococcic and other forms of purulent conjunctivitis the treatment by silver nitrate has always been a favorite, although the most varied opinions have been rife as to the dosage, frequency and method of its application. Personally, the Editor is in favor of exhibiting this remedy in small (1-5 to 1 per cent.) solutions in frequent doses as

an eye-water, painting the stronger (2 to 20 per cent.) solutions himself over the everted lids and neutralizing them with 5 per cent. salt solutions. The prolonged use of this and other silver salts is likely to be followed by staining of the conjunctiva. That a local argyrosis (grayish discoloration) may thus be induced should always be borne in mind, although it is only fair to say that conjunctival staining from silver nitrate is, in modern times, a rather rare phenomenon. Solutions of the nitrate should be made with distilled water, lest it throw down the insoluble silver chloride, in combination with the chlorides of sodium, potassium and magnesium that almost every natural water contains.

Generally speaking, the most successful employment of this remedy is in the various forms of conjunctivitis associated with a maximum amount of mucous and purulent secretion, and with a minimum of pain or irritation. It is particularly valuable in the blennorrhea of gonorrhea, both infantile and adult, as well as of streptococcus, staphylococcus, pneumococcus and "mixed" infections.

As an ointment nitrate of silver has long been used, particularly in ulcerative and other varieties of blepharitis. It forms the chief ingredient of Guthrie's salve (q. v.) but may be used alone with petrolatum in the proportion of a quarter to a half per cent.

As a prophylactic in all forms of ophthalmia neonatorum, Credé's method—one drop of a 2 per cent. solution dropped into the cleansed conjunctival sac at birth—still stands as the safest plan yet discovered.

For other purposes than those just mentioned, there are, doubtless, satisfactory substitutes [mainly salts of silver, such as argyrol, argentamin, protargol] for the nitrate. These may be equally efficacious, less irritating and less likely to produce pain, but if prescribed with judgment it seems likely that silver nitrate will continue to be of signal service to the ophthalmologist.

A few words as to the argyrosis oculi for which silver nitrate is occasionally responsible, De Micas (*L'Ophtalm. Provinciale*, May, 1913) presents from a medico-legal point of view, the case of a young law student who had his conjunctiva touched with a pencil of silver nitrate. He had suffered for some time from a chronic conjunctivitis, and had been treated by several oculists with various kinds of drops; on one occasion the conjunctiva was touched with a crystal of sulphate of copper. As he seemed to derive no benefit from the usual forms of treatment, his medical practitioner suggested that the mucous membrane should be cauterized with solid silver nitrate. No cocain was instilled, the entire palpebral conjunctiva was touched with the caustic, this was followed by lavage with a solution of sodium chloride.

The patient suffered intense agony for three days. It was then discovered, on examining the eyes, that the conjunctivæ were turgid and chemosed, and the corneæ opaque in their entire extent and ulcerated in the lower part on the right side. For some time afterwards, he complained of headaches, orbicular neuralgia, and there was considerable diminution of vision. He brought an action against his doctor, and was awarded damages to the extent of 20,000 francs.

De Micas discusses the case under the following headings: (1) Judicial opinions concerning the responsibility of medical men with regard to diagnosis. (2) The technique of cauterization of the conjunctiva with the silver nitrate pencil. (3) The relationship between the severity of the injury and the size of the indemnity. (P. A. Harry in the *Ophthalmoscope*, p. 396, Aug., 1915).

Komoto (*Centralbl. f. prak. Augenheilk.*, May, 1913) advises that if the argyrosis does not yield to the chemical treatment with sodium hyposulphite, or with the mixture of ammonium chloride and tartaric acid, that portion of the affected scleral conjunctiva which is ordinarily visible be excised and replaced by conjunctiva obtained from an enucleation or eventeration. The case which he reports was very successful.

Silver oxyquinoline-sulphonate. See **Argentol,** p. 564, Vol. I of this *Encyclopedia.*

Silver phenolsulphate. See **Silver sulphophenate.**

Silver-printing. The production of photographic prints by the agency of a salt of silver as sensitizer.

Silver-protalbin. See **Largin,** p. 7018, Vol. IX of this *Encyclopedia.*

Silver proteinate. Novargan. This silver albuminate, containing ten per cent. of the metal, is a fine, yellow powder, readily soluble in water and used, like argyrol, nargol, and largin, in those diseases of the eye where a non-irritating silver salt is required. It has about the same clinical value and is prescribed in the same dosage as protargol (q. v.).

Silver quinaseptalate. See **Argentol,** p. 564, Vol. I of this *Encyclopedia.*

Silver salvarsan. Delbanco (*Deutsch. Med. Wochenschr.*, Feb. 6, 1919; abs. *Journ. Am. Med. Assocn.*, May 31, 1919) comments on the new and supposedly more harmless salvarsan preparations which are now being made. He has applied silver salvarsan in 120 cases, making a total of 550 injections, all on outpatients, and has never witnessed any untoward manifestations. Only in five cases was there a tendency to transient congestion in the head, but these patients were soon able to go home alone. He cites as important Kolle's recent statement that colloidal silver alone has a pronounced action on syphilis in the rabbit. He suggests further that the way in which the spirochetes

take silver stains seems to indicate some special affinity for silver. He remarks parenthetically that it is inexplicable why the glass syringes seem to suffer from the silver salvarsan notwithstanding the colloidal character of the solution. Experimental syphilis in the rabbit has been very successful recently, even to spontaneous coitus chancres on the male rabbit. The blood of a syphilitic in the primary period, even without a positive seroreaction, injected into the rabbit testicle induces a typical primary lesion swarming with spirochetes; syphilis is thus a clinical septicemia from the very first. He adds that silver salvarsan in a dose of 0.2 gm. banishes the spirochetes from the primary lesion when examined against the dark field microscope.

Silver sodio-caseinate. See **Argonin**, p. 565, Vol I of this *Encyclopedia*.

Silver sulphichthyolate. Ichthargan. See **Silver ichthyolate.**

Silver sulphocarbolate. See **Silver sulphophenate.**

Silver sulphophenate. Silver sulphocarbolate. Silver phenolsulphate. This salt is found as colorless, odorless prismatic crystals with a marked metallic taste; soluble in 3 parts of water and 60 of alcohol. The aqueous solution, decomposed by light and heat, is used like itrol and argonin (q. v.) in ophthalmic practice in 1-500 to 100 solution and as a substitute for silver nitrate in half the strength of the latter.

Silver vitelline. See **Argyrol,** p. 570, Vol. I of this *Encyclopedia.*

Silvodide. A proprietary preparation, known as milk of silver iodid, used like the silver salts, as an antiseptic and germicide.

Silvol. A proprietary preparation, known as "milk of silver iodid," used like the silver salts, as an antiseptic and germicide in ocular and other affections. It is a soluble, non-irritating, non-toxic combination of colloidal silver with an albuminoid. It contains about 20 per cent. of silver, has a dark metallic appearance, and is supplied in the form of lustrous granules. It is slightly hygroscopic and therefore readily soluble in water. Permanent aqueous solutions having a characteristic dark-brown color may be prepared of any strength desired. These solutions are not precipitated by proteids or alkalies or any of the reagents that usually affect other silver compounds in solution. Silvol does not coagulate albumin or precipitate the chlorides when applied to living tissue.

Silvol is used in the treatment of conjunctivitis—gonorrheal, simple acute, and chronic—corneal ulcer, trachoma and other eye diseases.

Wm. C. White (*Jour. Ophthal., Otol. and Laryngol.*, Dec., 1915), points out some of the advantages of this preparation, as follows: 1. Quick solubility in any solution necessary for application to the mucous membranes. 2. Less staining properties than other proteid silver preparations. 3. High per cent. of silver content. 4. Minimum

amount of irritation when applied to the mucous surfaces. 5. Low per cent. solution necessary as compared to other similar preparations.

Simon, Gustav. A celebrated German surgeon (1824-1876) who seems to have written nothing on the eye, but who performed a very large number of ophthalmic operations. Owing to his insistence it was that, while he was a professor at Rostock, the professorate of surgery and ophthalmology was divided, the first thereafter to teach the latter branch being Carl Wilhelm Zehender. The most of Simon's life was passed at Heidelberg.—(T. H. S.)

Simpcox, Saunder. An exposed ophthalmic malingerer, made famous by Shakespeare, Sir Thomas More, and a number of other authors. As the story of this man possesses a decided ophthalmologic interest, we subjoin it here in full, as related by Shakespeare, in his King Henry VI, Part II, Act II, Scene 1:

Enter a Townsman of Saint Alban's, crying. "A Miracle!"

Gloster. What means this noise? Fellow, what miracle dost thou proclaim?

Townsman. A miracle! a miracle!

Suffolk. Come to the king, and tell him what miracle.

Townsman. Forsooth, a blind man at Saint Alban's shrine, within this half hour, hath receiv'd his sight; a man that ne'er saw in his life before.

King. Now, God be prais'd, that to believing souls gives light in darkness, comfort in despair!

Enter the Mayor *of Saint Alban's and his brethren, bearing* SIMPCOX, *between two in a chair,* SIMPCOX'S wife *following.*

Cardinal. Here comes the townsmen on procession, to present your highness with the man.

King. Great is his comfort in this earthly vale, although by his sight his sin be multiplied.

Gloster. Stand by, my masters; bring him near the king; his highness' pleasure is to talk with him.

King. Good fellow, tell us here the circumstance,, that we for thee may glorify the Lord. What, hast thou been long blind and now restor'd?

Simpcox. Born blind, an't please your grace.

Wife. Ay, indeed, was he.

Suffolk. What woman is this?

Wife. His wife, an't like your worship.

Gloster. Hadst thou been his mother, thou couldst have better told.

King. Where wert thou born?

Simpcox. At Berwick in the north, an't like your grace.

King. Poor soul, God's goodness hath been great to thee; let never day or night unhallow'd pass, but still remember what the Lord hath done.

Queen. Tell me, good fellow, cam'st thou here by chance, or of devotion, to this holy shrine?

Simpcox. God knows, of pure devotion; being call'd a hundred times and oftener, in my sleep, by good Saint Alban, who said, "Simpcox, come, come, offer at my shrine, and I will help thee."

Wife. Most true, forsooth! and many time and oft myself have heard a voice to call him so.

Cardinal. What, art thou lame?

Simpcox. Ay, God Almighty help me!

Suffolk. How cam'st thou so?

Simpcox. A fall off of a tree.

Wife. A plum-tree, master.

Gloster. How long hast thou been blind?

Simpcox. O, born so, master.

Gloster. What, and wouldst climb a tree?

Simpcox. But that in all my life, when I was a youth.

Wife. Too true; and bought his climbing very dear.

Gloster. Mass, thou lov'dst plums well, that wouldst venture so.

Simpcox. Alas, good master, my wife desir'd some damsons, and made me climb, with danger of my life.

Gloster. A subtle knave! but yet it shall not serve—Let me see thine eyes—Wink now;—now open them. In my opinion yet thou see'st not well.

Simpcox. Yes, master, clear as day, I thank God and Saint Alban.

Gloster. Say'st thou me so? What colour is this cloak of?

Simpcox. Red, master; red as blood.

Gloster. Why, that's well said. What colour is my gown of?

Simpcox. Black, forsooth; coal-black as jet.

King. Why, then, thou know'st what colour jet is of?

Suffolk. And yet, I think, jet did he never see.

Gloster. But cloaks and gowns, before this day, a many.

Wife. Never, before this day, in all his life.

Gloster. Tell me, sirrah, what's my name?

Simpcox. Alas, master, I know not.

Gloster. What's his name?

Simpcox. I know not.

Gloster. Nor his?

Simpcox. No, indeed, master.

Gloster. What's thine own name?

Simpcox. Saunder Simpcox, an if it please you, master.

Gloster. Then, Saunder, sit there, the lyingest knave in Christendom. If thou hadst been born blind, thou mightst as well have known all our names as thus to name the several colours we do wear. Sight may distinguish of colours, but suddenly to nominate them all, it is impossible. My lords, Saint Alban here hath done a miracle; and would ye not think his cunning to be great that could restore this cripple to his legs again?

Simpcox. O master, that you could!

Gloster. My masters of Saint Alban's, have you not beadles in your town, and things called whips?

Mayor. Yes, my lord, if it please your grace.

Gloster. Then send for one presently.

Mayor. Sirrah, go fetch the beadle hither straight.

[*Exit an Attendant.*]

Gloster. Now fetch me a stool hither by and by. Now, sirrah, if you mean to save yourself from whipping, leap me over this stool and run away.

Simpcox. Alas, master, I am not able to stand alone; you go about to torture me in vain.

[*Enter a Beadle with whips.*]

Gloster. Well, sir, we must have you find your legs. Sirrah beadle, whip him till he leap over that same stool.

Beadle. I will, my lord. Come on sirrah, off with your doublet quickly.

Simpcox. Alas, master, what shall I do? I am not able to stand.

[*After the beadle hath hit him once, he leaps over the stool and runs away; and they follow and cry, "A miracle!"*]

King. O God, seest thou this, and bearest so long?

Queen. It made me laugh to see the villain run.

Gloster. Follow the knave; and take this drab away.

Wife. Alas, sir, we did it for pure need.

Gloster. Let them be whipped through every market-town till they come to Berwick, from whence they came.

[*Exeunt Wife, Beadle, Mayor, etc.*]

Cardinal. Duke Humphrey has done a miracle to-day.

Suffolk. True; made the lame to leap and fly away.

Gloster. But you have done more miracles than I; you made in a day, my lord, whole towns to fly.

The story was taken by Shakespeare from the account of Sir Thomas More, who, in turn, had probably received it from Grafton's "*Chronicle.*"—(T. H. S.)

Simple colors. Primary colors.
Simple conjunctivitis. Catarrhal conjunctivitis.
Simple eye. A single eye.
Simple granular conjunctivitis. The non-trachomatous form of the disease.
Simple iridochoroiditis. Plastic iridochoroiditis.
Simple keratomalacia. See **Keratitis, Xerotic.**
Simple ointment. See **Unguentum simplex.**
Simple optical system. See **Physiological optics,** p. 9728, Vol. XIII of this *Encyclopedia.*
Simple syrup. A plain solution of cane sugar in water. See **Sugar.**
Simple trephining of the sclera. See **Trephining.**
Simplex eyes. A nomenclature adopted by Hurst (*Lancet*, Nov., 29th, 1913). Eyes which have in the iris no visible stroma pigment are classed as "simplex," those which have stroma pigment, in addition to retinal pigment, are called "duplex." The latter class is subdivided into "duplex medium" and "duplex dark." In the first place, in order to determine the normal proportion in the district, 1163 school children were examined; 29.8 per cent. had simplex eyes, 35.9 per cent. duplex medium, and 34.3 per cent. duplex dark. Next, in 679 cases of scarlet fever 32.3 per cent. had simplex eyes, 38.4 duplex medium, and 29.3 duplex dark. Those who suffered from the disease severely were, simplex 21.0 per cent., duplex medium 15.7 per cent., duplex dark 15.5 per cent. The fatality percentage was 7, 5, and 3 respectively. It would appear, says the author, that scarlet fever is more frequently severe, and has the highest mortality, in simplex-eyed children. The results were more decided in diphtheria, simplex-eyed children being more definitely in excess as compared with the general population, while the darker the type the less was the proportion. For the three types the incidence was 38.1 per cent., 32.6 per cent. and 29.3 per cent. respectively, while the percentage fatality was 10.2 per cent., 4.7 per cent. and 2.6 per cent. respectively.

The expression "blue eyes" (*Journ. Am. Med. Assocn.,* Dec. 2, 1916) as used colloquially has not a very sharply-defined meaning. It should be reserved for such eyes as have no pigment in the iris except that of the posterior pigmented layer, "uvea." Such eyes are scientifically called "simplex." Owing to variations in the connective tissue structures, simplex eyes may also be gray. According to A. D. Darbishire (*Breeding and Mendelian Discovery,* Ed. 2, Lond.): The offspring of a man and woman both possessing blue eyes and both descended from duplex parents on both sides, in both cases will possess blue eyes as certainly as if their four grandparents all had blue eyes.

The offspring of the union of two persons with simplex eyes, whatever their ancestry is, will never have brown eyes.

On this point there is no difference of opinion among authorities on genetics. (See also Davenport, *Heredity and Relation to Eugenics.*) The determination of the simplex or duplex pigmentary character of the iris is not easy.

Simplex oculus. Also called monoculus. A bandage used to keep in place a topical application to one eye.

Simpson light. As noted by Harmer and Cumberbach (*Lancet,* Jan. 8, 1916), the Simpson light is emitted from an electric arc formed between electrodes made by a special process from a mixture of the ores of certain metals, the chief one being a tungstate of iron and manganese, known as wolfram. The Simpson light is made up of rays of two kinds: 1. Visible rays: These are the visible rays of the luminous spectrum, violet, blue, green, etc., down to red; these rays together produce white light. 2. Invisible rays: These are heat rays and ultraviolet rays. It is to the latter that the therapeutic properties of the light are said to be due. At St. Bartholomew's Hospital (London) a number of cases with various types of disease have been treated: rodent ulcer; lupus; syphilis; asthma; vasomotor rhinitis; nasal catarrh and sinuitis; otosclerosis and eczema. The Simpson light seems to stimulate the healing of wounds. Cases of shrapnel wound have been benefited. When disease affects the deep parts of subcutaneous parts there is usually no benefit.

Sims. A term used in comparative biology to designate a superior ciliary process, morphologically intermediate between the iris and a full-sized ciliary process.

Simulacrum. (a) An image or shadowy likeness of anything. (b) A formal sign.

Simulated blindness. SIMULATED AMBLYOPIA. SIMULATION OF OCULAR DISEASE. FALSE PRETENCE OF OPHTHALMIC DEFECTS.

See **Legal relations of ophthalmology**; as well as **Blindness, Simulation of,** p. 1188, Vol. II; and **Malingering,** p. 7593, Vol. X of this *Encyclopedia.*

Simultaneous contrast. A form of contrast of colors in which, when two contiguous colors are fixed at the same time, the impressions of the two colors are blended. See p. 3276, Vol. V of this *Encyclopedia.*

Sinchisi del corpo vitreo. (It.) Synchisis scintillans.

Sinclair, Alexander Grant. A prominent ophthalmologist of Memphis, Tenn. Born at Charlottenburgh, Ont., Canada, July 30, 1842, he received the medical degree at the College of Physicians and Surgeons

in the City of New York in 1869. For a year or more he studied ophthalmology and oto-laryngology in Vienna. For a time he practised as ophthalmologist and oto-laryngologist in Detroit, but, removing about 1880 to Memphis, he was made ophthalmic and aural surgeon and laryngologist to St. Joseph's Hospital and St. Peter's Orphan Asylum, and ophthalmic surgeon to the Old Ladies' Home and City Hospital, as well as dean and professor (afterwards emeritus professor) of ophthalmology, otology, laryngology and hygiene in the Memphis, Tenn., Hospital Medical College. He was also for a time vice president of the American Medical Editors' Association.

Alexander Grant Sinclair.

Sinclair never married. He was a large, dark man, with a sombre, almost melancholy habitual air. His attitude toward his professional brethren was cordial, but reserved. He was extremely fond of animals, and an active promoter of the Audubon Society's work. He was always an independent in politics. He belonged to the Baptist Church and was active in its service. For a long time, in fact, he was chairman of the Board of Deacons. He had extensive business interests in Memphis, being a member of the boards of directors of several banks and other business institutions. He died in the Baptist Memorial Hospital, Memphis, on Dec. 18, 1915, from pneumonia.—(T. H. S.)

Sine-condition. A stipulation, established by Abbe, that all the zones of an optical system corrected for spherical aberration shall produce images of the same size upon the axis at the conjugate object points and image-points, and which is satisfied for all rays traversing the system when the ratio of the slope-angles of each pair of corresponding incident and emergent rays is a constant. Thus, if θ is the slope-angle of the object-ray, and θ' the slope-angle of the image-ray, then $\sin \theta / \sin \theta'$ is equal to a constant whose value is n'Y/n, wherein n and n' are the refractive indices, respectively, of the first and second medium, and Y, the linear magnification (q. v.).—(C. F. P.)

Single vision, Binocular. See **Binocular single vision,** p. 970, Vol. II of this *Encyclopedia.*

Sinic ink. Chinese or Indian ink.

Sinistrad. Towards the left side.

Sinistral. Left hand; not dextral.

Sinistrocular. Left-eyed; having the left eye the stronger.

Sinistrocularity. The state of having the left eye the stronger.

Sinistrophoria. A term proposed by Valk to define an abnormal rotation of each eye to the left. It is less common than the opposite condition of *dextrophoria,* (q. v.).

Sinistrotorsion. A twisting toward the left: used mainly of the eye.

Sinneseindruck. (G.) A sensory impression.

Sinnesorgane. (G.) Organs of special sense.

Sinuous lid border. This condition is given (*Trans. Oph. Soc. U. K.,* p. 38, 1907) as a sign of trachoma.

Sinus, Cavernous, Ocular relations of the. See **Cavernous sinus, Ocular relations of the,** p. 1794, Vol. III of this *Encyclopedia.*

Sinus conjunctivæ. Conjunctival sac.

Sinuses, Accessory, Ophthalmic relations of the. See **Cavities, Neighboring, Ophthalmic Relations of,** p. 1810, Vol. III of this *Encyclopedia.*

Sinusoidal current. See p. 4190, Vol. VI of this *Encyclopedia.*

Sinus ophthalmicus. The cavernous sinus.

Siphon-barometer. A barometer, the lower end of the tube of which is bent upwards.

Siphon-gauge. A mercurial vacuum-gauge.

Sixth nerve. The abducens or abducent nerve, which supplies the external rectus muscle. See p. 411, Vol. I of this *Encyclopedia.*

Sixth nerve paralysis. See **Abducens paralysis,** p. 22, Vol. I of this *Encyclopedia.*

Size of objects. See **Apparent size of objects,** p. 538, Vol. I of this *Encyclopedia.* In addition to the matter found there it may here be

noted that S. A. Kinnier Wilson (*Trans. Ophth. Soc. U. K.*, Vol. XXXVI, p. 412, 1916; reviewed in *Br. Journal of Ophthalm.*, p. 320, 1917) prefers the term *dysmetropsia* to the previously used term *dysmegalopsia* for the class of cases in which there is defect in the visual appreciation of the measure of size of objects, whether by over-estimation or under-estimation. He passes briefly over the occurrence of this phenomenon under physiological conditions to the consideration of its appearance in definite pathological states.

Among the diseases in which it has come under the author's own observation are such varied conditions as tabes dorsalis, syphilitic basal meningitis, disseminated sclerosis, migraine, cerebral tumor, cerebral softening, epilepsy (both grand and petiti mal), and hysteria.

He makes a provisional classification into two main groups, viz., dysmetropsia of peripheral origin and of central origin. The latter group may be further subdivided into cortical and transcortical varieties.

As types of the first group the cases used are one of tabes, one of syphilitic basal meningitis, and one of disseminated sclerosis. In the last case the defect was not so much in estimating the size of objects as their distance.

To illustrate the second group, subdivision (a) cortical or subcortical group (projection system), he describes a case of migraine and one of epilepsy. To illustrate subdivision (b) transcortical group (associative systems) including so-called psychical cases, he describes two hysterical cases and one of cerebral tumor with Jacksonian epilepsy.

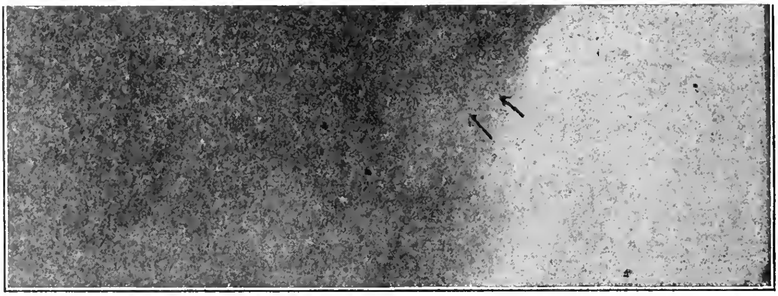
A diagram illustrating Hughlings Jackson's "lowest, middle, and highest levels" explains the classification scheme. Thus, the peripheral mechanism or "lowest level" starts at the retina, inflammation of which may be accompanied by dysmetropsia from displacement of retinal end organs. It will include on the sensory side the afferent stimuli from the contracting ocular and ciliary muscles. Wilson does not consider that these stimuli have much, if any, share in the production of dysmetropsia. On the motor side there is the set of lower motor neurones from the linked oculomotor nuclei in the midbrain to the internal recti, ciliary muscles, and the sphincters of the irides. He quotes Fuchs explanation of the micropsia said to occur in paralysis of accommodation and the macropsia said to occur in spasm of accommodation. With this he does not agree, as he cannot admit that there is such a thing as a motor-cell sensation, and says that there is no satisfactory evidence that a motor-innervation current of itself produces a sensation of strain or effort. Wilson himself very much doubts, from his own observation, if dysmetropsia does occur in paralysis or

spasm of accommodation, but considers that a more appropriate explanation would attribute it to a disturbance produced by interference with the accommodation in the acquired retinal scheme, or system, whereby we determine the relative size and distance of objects.

Wilson devotes some space to the vexed question of the mechanism of the estimation of distance. He is of the opinion that accommodative effort, as such, has little importance, and that the different factors,

Skiagraph of Various Varieties of Glass. (Sweet.)
(See definition on next fol lowing page.)

1, Lead glass. 2, Piece of lens. 3, Piece of chemical glass. 4, Piece of soda-water bottle. 5, Druggist's green bottle. 6, Locomotive gauge glass. (One-half inch board between particles and plate. Expose, 15 seconds.)



Skiagraph. (See definition on next following page.)

Illustrates Sweet's case in which there were two large pieces (radiograph) of stone in the globe.

retinal disparation and psychology, play parts differing widely in various individuals. As regards the influence of the accommodation, he says that it is more probable that the necessary afferent stimuli for the activity of the cortical accommodation centres are derived from retinal impressions passing first to the cortical half-vision centres and thence to the cortical accommodation centre.

Sizer, Lens. See **Lens sizer,** p. 7416, Vol. X of this *Encyclopedia.*

Skeel perimeter. See p. 9460. Vol. XII of this *Encyclopedia.*

Skeins, Test. Holmgren's worsted yarns for testing color-blindness. See **Examination of the eye.**

Skiagram. See **Skiagraph.**

Skiagraph. SKIAGRAM. A permanent shadow picture produced by Roentgen rays. (See illustrations on p. 11792.)

Skiagraphy. See **Radiography.**

Skiakineskopy. A modification of kinescopy (see p. 6847, Vol. IX of this *Encyclopedia*). A method employed by Holth (*Annales d'Oculistique,* Vol. 131, p. 418) for estimating refraction.

Skiameter. An instrument for measuring the intensity of the Röntgen rays, and thus determining how long an exposure is needed.

Skiametry, Dynamic, and other dynamic ocular tests. This heading should be read in connection with the same or similar topics that are especially discussed under **Physiologic optics,** as well as under **Skiascopy**; the first part of **Muscles, Ocular**; **Examination of the eye,** in this *Encyclopedia.*

As this section is, in the nature of things, an extensive one, the subject is divided into chapters and introduced by a table of contents.

Elimination of Scissor Movements—Astigmatic Conditions—Presbyopia—Subnormal Accommodation—Cases.

Chapter IV. SUBJECTIVE AND OBJECTIVE METHODS OF DETERMINING THE RANGE AND AMPLITUDE OF ACCOMMODATION.

Determination of the Situation of the Near-point and, thereby, the Accommodative Amplitude—Determination of the Amplitude by Lenses at Infinity—Determination of the Amplitude by Concave Lenses at the Reading Point—Objective Method of Determining the Monocular Amplitude—Objective Method for Binocular Amplitudes—Cases.

Chapter V. TONIC, ACCOMMODATIVE AND FUSION CONVERGENCES AND THEIR IMPORTANCE IN REFRACTIVE WORK.

Physiologic Exophoria—Tonic Convergence—Accommodative Convergence—Fusion Convergence—Clinical Methods of Testing the Accommodative Convergence—Fusion Convergence and its Clinical Measurement—Duction Tests—Version Tests—Reserve Fusion Convergences Tests—The Economic Coordination of Accommodation, Accommodative and Fusion Convergences—Cases.

Chapter VI. A CHAPTER OF CASES ILLUSTRATING VARIOUS DYNAMIC OCULAR TESTS.

Outline of the Routine of Examination—Cases.

Chapter I. GENERAL STATEMENT OF THE METHOD OF DYNAMIC SKIAMETRY.

Static skiametry involves the determination of the refractive error of an eye when it is in the condition of passively fixing a very distant object or when its ciliary is under the subjugation of a cycloplegic. *Dynamic* skiametry, on the other hand, involves the determination of those lens quantities which make the retina of the eye under test and the object—definitely fixed and usually at a close distance relatively from the eye—conjugate points. In the former set of tests accommodative suppression and relaxation are demanded; in the second set, however, when both eyes are fixing in the act of binocular single vision and endeavoring to read a diminutive chart or card of printed matter at close range, the maximum stimulation

to the development of the accommodative changes necessary is invoked. In so far as the technique of shadow movements in the two methods is concerned it may be stated that the dynamic method may be practised almost at will by a person thoroughly familiar with the principles of static skiametry, or retinoscopy as it is commonly called. Ordinarily it is taught, and correctly so from theoretical principles, that an allowance of one diopter should be made in static methods for a working distance of one meter: for example, a neutral shadow obtained with a + 4 D. S. at one meter would indicate a demanded correction, theoretically, of + 3 D. S. Parenthetically we would call attention to the statement made by Alger *(The Refraction and Motility of the Eye)* that, when working at one meter and not using a cycloplegic, the skiametric findings in order to produce a neutral shadow at the distance of one meter should be recorded as the correct findings without making the allowance for the working distance. The writer cannot accept in full this statement, but here records the fact that for years he has worked at about 26 inches and allowed only one diopter instead of a diopter and a half for the working distance, and finds that the skiametric findings thus obtained approximate very closely the finally determined upon prescription in most cases presenting no peculiar conditions of muscular imbalance or accommodative anomalies. In dynamic skiametry, as practised in one of its phases, no allowance for the working distance is made, provided

Fig. 1.—Fixation Stand and its Use in Dynamic Skiametry. Illustrative of fixation and observation in the same plane. (Sheard.)

the point of fixation on the part of the patient and the point from which observations as to the shadow movements are made by the practitioner (technically, the nodal point of the observing eye), are one and the same. This requirement may be accomplished in one of two ways: (1) By the use of a fixation stand carrying a set of small letters and so forth placed in the same plane as that in which the skiascopist works (*vide* Figure 1). The person under test looks at the objects on the fixation stand while the observer works either close to one side of the stand or just over it. (2) By the use of a small

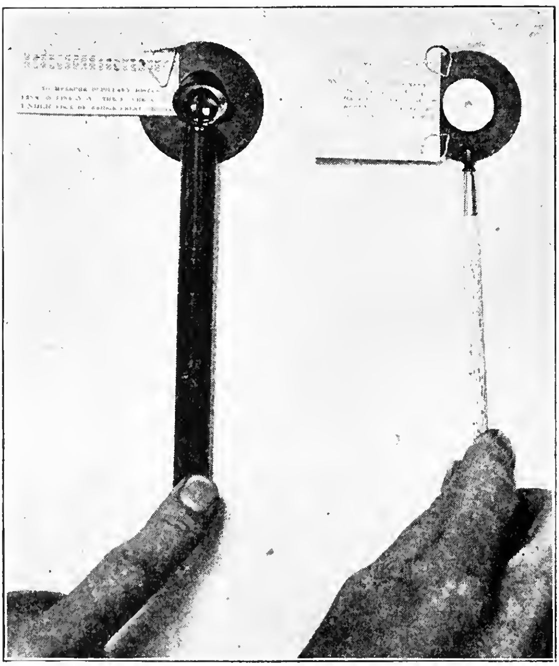


Fig. 2.—A Simple Form of Skiameter for Use in Dynamic Work. (Sheard.)

card carrying various symbols or letters printed in fairly large type (about 12 point is used by the writer): or a set of hit and miss letters, or points and dots to be counted, (*vide* Figure 2). In either case the desire on the part of the skiametrist is to have the patient exert accommodation and convergence to the full or requisite amount, in so far as possible, for the point under observation and to keep the attention fixed while he makes his tests. In either of these methods the fixation and observation planes are practically the same. We shall discuss briefly in other paragraphs a method of usage in which this condition need not be met: in other words, for example, fixation

may be made at one meter and the reversal point sought without the use of lenses, due allowance being made for the one diopter of artificial accommodative myopia produced by reason of the fixation at one meter.

The skiascopic test by the dynamic method does not involve the occlusion of one eye while the other is under test, as is commonly the case in the static methods. Hence, in a certain measure, the dynamic skiametric test is always a *binocular* one, for both eyes are involved in the sense that both accommodation and convergence are demanded in order that binocular single vision may ensue. The coordinations of the functions of accommodation and convergence are probably as numerous as are the pairs of eyes tested: hence it is to be expected that the dynamic skiametric findings will not, for example, necessarily be identical even in cases in which the static findings, the amplitudes of accommodation and the convergence reserves, are the same. Furthermore, if one eye is occluded, or is blind, or so amblyopic as to be of no account in close seeing, the methods of dynamic skiametry are still available and applicable but we are forced to believe, as the writer sees it, that we are then testing objectively for the determination of the lens quantity which this eye will accept in order that it may easily and under its best working conditions see the object looked at.

Dynamic Skiametric Procedure (Cross).

The dynamic skiametric method as devised by A. J. Cross, of New York, in the early '80s, consists in having the patient read the letters or count the dots on a fixation chart while the examiner takes note of the character of the reflex (or shadow) in each eye, one eye after the other. Should the examiner find a "with" motion, using a plane mirror, he then proceeds to add such convex lenses as will give a slight over-correction binocularly as evidenced by the "against" character of the shadows. Cross recommends the use of his own peculiar form of skiascope. This carries a light frame attached to the mirror support and fastened in such a manner that one fixation card is slightly behind and the other slightly in front of the operator's nodal point, (*vide* Figure 3). The fundamental notion underlying this device is that when full correction has been approximated with fixation upon the card the more remote from the subject's eye, a quick change to the slightly nearer fixation object is made possible and that, if there is then a reversal of shadow in passing from fixation upon the first to fixation upon the second point, a correct refractive finding as to the needs of a pair of eyes has been determined upon in order that the

accommodative needs and their coordination and correlation with convergence may be fulfilled at the *point fixed.* We believe that this covers, in essentials, the mechanical procedure unless there be added to these remarks the further statement that, should an "against" motion be obtained with a plane mirror and with fixation and observation at any given point, concave lenses are added until a neutral

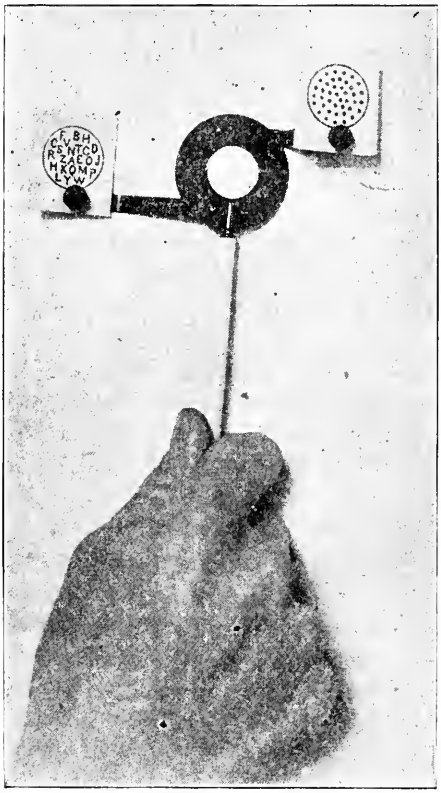


Fig. 3.—The Cross Dynamic Skiameter.

shadow is obtained in both eyes. The fixation point, when fixation and skiascopic observation distances are one and the same, may be varied to suit the practitioner. Commonly chosen points vary from ten to twenty inches from the patient.

This method, which may be designated as the *simultaneous fixation-observation* procedure, may be modified as has been suggested by Cross and fixation may be demanded at any desired point through the use of a suitable chart or test object placed at the proper distance,

while the reversal of skiascopic shadows is sought at another point. For example, fixation may be made at forty inches and the reversal sought and found at twenty-six inches in a particular case, for instance. This procedure is analogous to that which may be used in myopic cases under static retinoscopic methods in which points or positions of reversal may be located. The writer rarely uses either of these static or dynamic determinations of reversal point methods for the reason that measurements of distances are too inconveniently made and, again, are likely to be too inaccurate to be of value from an exact refractive standpoint, especially when these distances to be measured are from points close to the eyes. This measurement method of finding the skiascopic neutralizing lens quantity is, however, very rapid and satisfactory for obtaining the order and magnitude of the error in either the static or dynamic procedures, particularly where the reversal point is within a one-meter distance. This "fixation at one point and observation at another point" method of operation in dynamic skiametry has been criticized by many on the basis that it is impossible for the patient to read the letters on a chart and still have an observational reversal point on the part of the operator at another position. This criticism is unwarranted for two reasons: first, the ability either to read or not read the letters looked at is not the criterion, for the purpose of this fixation is to induce the person under test to *endeavor* to decipher the letters or to count the dots as the case may be; and second, such criticism is unwarranted if the examination is made by this method *without* the use of any *spherical lenses*, cylindrical lenses only being employed to correct any astigmatic error which may be found in the course of the examination. For it is to be remembered that ray values, as Cross calls them, i. e., distances of observation on the part of the operator or distances of objects fixed by the subject, have their equivalent lenticular counterparts. To illustrate, if fixation should be made at 20 inches and the operator should find a neutral point at one and a half meter (equivalent to 0.62 D. S. practically) then, under the procedure as we have outlined it and through the explanations to follow in detail in later paragraphs we have evidence that + 1.37 lenses — the difference between the equivalent of 20 inches or 2 D. and the equivalent of the reversal point or 0.62 D. — are required in order that the positive range of relative accommodation, the negative range of relative accommodation and the convergence may be properly correlated.

Sheard's Method.

The mechanical procedure which the writer follows is somewhat different from that used by Cross. Initially we find by static skiascopic

methods those refractive findings which put the eyes monocularly in an optical condition such that the retina and the distant point, presumably passively fixed, are conjugate points. These static findings, minus any cylindrical corrections which may have been added, are then left before the eyes under test and the patient is directed to the card of small print attached to the mirror. The patient is then instructed to read, or to endeavor to so do, the letters on this card. The character of the shadow is quickly noted in each eye and sufficient spherical lens changes made and, if necessary, cylinders added until the shadows in both eyes are *neutral.* We are accustomed to make these determinations at the point at which the subject says that ordinary reading and close work are done. Whatever conclusions the reader or the user of dynamic skiametry may reach or have previously reached as to the value of these determinations, and irrespective of what may be accepted or rejected of that which follows, we are of the conviction that this method does, in general, give us valuable information as to the lenticular assistance needed when the eyes (or eye in monocular vision) are engaged in the visual act at the point fixed. In passing, let it be stated that the card which serves as the test-object should be sufficiently illuminated; we carry out these tests in a room reasonably well lighted: in fact, there is no difficulty in carrying out dynamic skiametric tests in a room lighted by indirect or semi-indirect systems.

Chapter II. Relative accommodation and convergence. Dynamic skiametry as an objective method of measuring relative accommodation.

In his presentation of the theory of dynamic skiametry Cross writes: "While the static method of practicing skiametry is one in which the ciliary muscle is at rest, the dynamic method is the exact reverse of this, and is made while the accommodation is exerting itself sufficiently to readily accept refractive assistance up to the point where its relation with convergence is interfered with. * * * So in dynamic skiametry a call is made for a pronounced increase of the accommodation by having the patient read a series of test letters placed on the observer's brow,"—(the writer then gives other methods),— * * * "then varying this tension as judgment teaches, and by being able to supply required artificial lens power, *the accommodation is reduced to its normal relationship with convergence.* And most eyes, no matter what the age of the patient may

be, *will only surrender the accommodative excess* which has been required to maintain near-vision. * * * The relationship between accommodation and convergence, if roughly stated, is found to be in about the proportion of one to three for the two eyes." The writer's interpretation of these statements is that Cross believes that the accommodative excess will be surrendered only to the extent of a normal "one to three" ratio between accommodation and convergence.

The writer is not entirely in accord with the theory and statements of Cross as quoted above and as amplified in his writings on this topic. He is, however, in agreement with the statement that tests can be made skiametrically whereby it is possible to determine when the accommodative demands have been met in a manner such as to leave a pair of eyes definitely fixing a given point and yet neither expending too much accommodative effort, on the one hand, nor too little on the other.

The question may, therefore, be very properly raised at this juncture: Is not dynamic skiametry, when practised with fixation and observation points identical, and convex lens power added until *reversal* occurs, simply and purely an *objective method of determining the negative range of relative accommodation?* We believe that it is, and if it should serve no other purpose than this, it is a most valuable objective method in the investigation of ocular relationships. A citation from Cross (which can be repeated by anyone in almost any case of a low degree of hyperopia) supports the view that his method of procedure and his interpretation of his findings are such as to lead us to believe that he considers it chiefly as an objective method of determining the negative relative accommodation and from such determinations the actual amount of lenticular assistance demanded in any particular case. He writes: "Case 1. Fixation 40 inches; observation 39 inches. Shadow *with* the mirror. Can add + 1 D. before *reversal* occurs. But with fixation and observation at sixteen inches, a total of + 1.5 D. can be added before reversal takes place. Same result is obtained with observation and fixation at thirteen inches." These results are in accord with an affirmative answer to our query, for relative accommodation—convergence determinations show, except in unusual cases, a decrease in the positive range and an increase in the negative range and amplitude of relative accommodation as the point of fixation—and therefore the amount of convergence demanded—is approached toward the eyes.

A discussion and brief description of the fundamental points with respect to methods of determining the relative ranges and amplitudes of accommodation and convergence must be indulged in before we

can proceed to further deductions as to just what significance the findings by dynamic skiametry carry. The amount of accommodation which is possible for an individual to exert or to relax with reference to a given degree of convergence is known as the *relative accommodation.* Donders demonstrated that, for nearly all points within the range of binocular vision, accommodation and convergence are, to a certain extent, independent of each other. All dynamic tests upon the eyes must take cognizance of both the *independence* and the *interdependence* of accommodation and convergence. There are, then, two fundamental questions which may be asked as to the relationship between accommodation and convergence.

First. *Convergence* remaining the same, by how many diopters can accommodation be increased or diminished?

Second. *Accommodation* remaining unchanged, by how many meter-angles (or prism dioptries) can convergence be increased or diminished?

The Technique of Relative Accommodation Tests.

Dynamic skiametry, in certain of its phases at least, having to do with conditions of relative accommodation for various fixation points, must be intimately associated in its theoretical phases with the answer to the first of these questions. Let us, therefore, consider methods for the measurement of relative accommodation for clinical purposes. We have, in such tests, to determine the positive side and the negative side of the relative range of accommodation at any given point. The first of these is determined by concave lenses and the second by convex lenses. We proceed somewhat as follows: The person under test looks at the standard test line and the maximum negative and maximum positive lenses determined upon—the same lens quantities being inserted before both eyes—through which the person under test is able to distinguish or read the letters. These lens values give the dioptric equivalents of the positive and negative sides of the relative accommodation with visual axes parallel, i. e., convergence nil. Tests at closer points are then instituted, the first position usually being at one meter. The writer is familiar with two devices for such tests: these are known as the optometer due to Howe and the ophthalmodynamometer due to Gardiner. Howe has succeeded in devising by photographic means a near test-chart constructed on the basis of the minimum angle of fifty-five seconds which is adaptable for testing the relative accommodation at each meter-angle from one to twenty. The Gardiner instrument is provided with a slide carrying a card printed in several sizes of Gothic letter. But both methods suffer from the

fact that when "Tests are made on persons whose vision is not perfect, or cannot be brought near to the standard of perfection by suitable glasses, a corresponding allowance must be made" (Howe). Using, then, either the Howe or Gardiner or similar apparatus with appropriate test-objects, the fixation point may be made, for example, at forty centimeters. This demands normally an accommodation of two diopters and a convergence of two meter-angles (i. e., about 7° of actual convergence of the eyes or the equivalent of about 12Δ to 14Δ). By placing negative lenses in the holders there is found the strongest concave lenses through which the person under test can still read the line of type initially read. The power of these lenses in diopters indicates the positive side of the relative range of accommodation at the half-meter point. Without changing the fixation point, the maximum convex lenses, under similar conditions of visual acuity as those specified in the foregoing sentences, give the negative amplitude of relative accommodation. These tests can be continued until the binocular punctum proximum is reached, when the patient can no longer read through any negative lenses, showing that the limit of the positive accommodation has been reached. The patient can, however, still read through convex lenses, thus indicating that there is still operative a negative range of relative accommodation. From these data thus obtained most interesting and valuable relationships can be plotted as curves showing the convergences in meter-angles as the abscissas and the values of the maximum positive and negative lenses used at any point of convergence as the ordinates (*vide* Howe, *Muscles of the Eyes*, Vol. I, pages 324-328; Donders, *Accommodation and Refraction of the Eye*, pages 110-125; Landolt, *The Refraction and Accommodation of the Eye*, pages 195-218).

Let us, as a simple illustration, assume an emmetropic condition. We find the *positive* part of the relative accommodation at six meters by inserting before the patient's eyes the strongest concave lenses which do not make unreadable the line which should be read at that distance. These lenses represent approximately the degree of extra accommodation made possible through the agency of the ciliary muscles. Let us suppose that they are —3.25 D. S. The real amount of positive accommodation, due allowance being made for the distances of the lenses from the eyes, amounts to about 3 D. S. The *negative* portion of the relative accommodation should next be measured by using convex lenses. Inasmuch, however, as we have assumed emmetropia we have an actual negative relative accommodation at six meters of zero value. Let us next take convergence at one meter, using the Howe or Gardiner instrument or, as a last resort, the fine type on

the ordinary reading charts. An emmetrope at one meter's fixation distance normally exerts one diopter of accommodation. We then find the strongest concave glasses that can be overcome in the manner previously described. Suppose these to be — 3.00 D. S. The actual amount of positive relative accommodation at one meter can be shown to be about 2.75 diopters, since calculations (*vide* Howe's *Muscles of the Eyes* and Sheard's *Physiological Optics*) indicate that the total accommodation is 3.75 diopters, of which the emmetropic eye without a lens, converging at one meter, will exert one diopter. The negative part of the relative accommodation with one meter-angle of convergence must next be obtained. This is done by the employment of convex lenses until the type normally readable at the distance at which the tests are made begins to be blurred and unreadable. Suppose this is + 0.75 D. S. The total amplitude of the relative accommodation at the one meter point is, therefore, 3.50 D. S. Other measurements at two, three, etc. meter-angles of convergence can then be made.

The accompanying table (taken from Howe's *Muscles of the Eye,* Vol. I, page 319) gives a sample set of data on relative accommodation. The negative lens overcome, when proper correction is mathematically made for the distance of the lens, as ordinarily placed in testing, from the nodal point of the eye, gives the actual positive accommodation recorded in the fourth column. A similar statement is applicable to the data on the negative relative accommodation as measured through the use of convex lenses.

Table of relative accommodations.

Meter Angles	Accommodation	— Glass Overcome	Total Relative Acc.	Actual + Accommodation	+ Glass Overcome	Actual — Acc.
0	0	— 3.25	2.95	0	0	2.95
1	1	— 3	2.59	+ 0.75	0.72	3.31
2	2	— 3	2.44	+ 1.5	1.38	3.82
3	3	— 2.5	1.95	+ 2.0	1.74	3.69
4	4	— 2	1.46	+ 2.25	1.85	3.31
5	5	— 1.5	1.06	+ 2.50	1.90	2.96
6	6	— 1.0	0.71	+ 3.25	2.34	3.05
7	7	— 0.75	0.51	+ 4.5	3.08	3.59
8	8	0	0	+ 5.5	3.61	3.61

In Figure 4 there is plotted a set of curves showing the relation between the positive and negative portions of the relative accommodation and convergence employing the data contained in the foregoing table. The diagonal running across from the lower left-hand to the

upper right-hand corner represents the relation which would exist if there was found to be absolutely one meter-angle of convergence associated with each diopter of accommodation. Hence the positive part of the relative accommodation is recorded above the diagonal and the negative part below it: the accommodation values are usually plotted vertically as shown and the convergence values horizontally. In Figure 4, for example, with fixation at infinity in a specific case of emmetropia, the positive relative accommodation is plotted as 3 diopters while the negative relation accommodation is zero. Passing to 1 M. A. of convergence, we proceed to plot the positive and negative

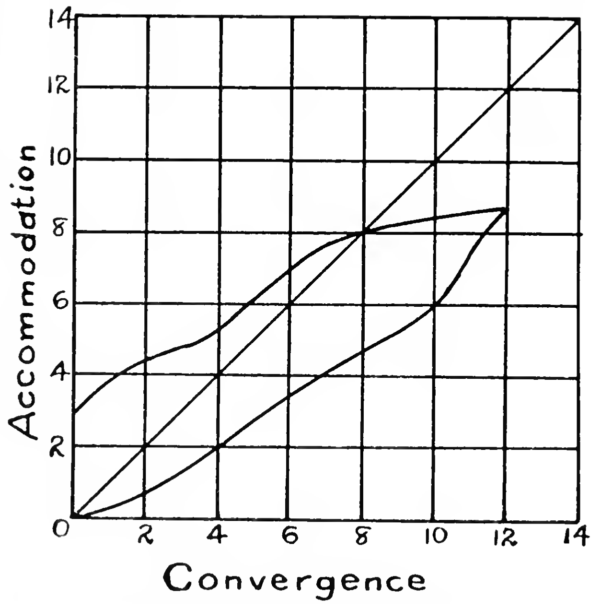


Fig. 4.—Relative Accommodation Curve. (Howe.)

relative accommodations from the diagonal line at the point opposite 1 D. of accommodation and 1 M. A. of convergence, and not from the horizontal axis. From the diagram as plotted we see that the positive relative accommodation at 1 M. A. of convergence is equal to 3.5 — 1 = 2.5 diopters and the negative accommodation is 1 — 0.25 = 0.75 diopter. When there is no longer any positive portion of the relative accommodation the curve crosses the diagonal.

The technique of measuring the relative range of accommodation in ametropia does not differ from that outlined for emmetropia, but the altered relations between the functions must always be taken into account. Thus, in cases of myopia, convergency may occur while there

is no accommodative demand; in a case of myopia of 4 D., uncorrected, there would be a convergence of six meter-angles, for example, with an accommodation of two diopters only. In hyperopia, on the other hand, there would be more accommodation than convergence; a hyperope of two diopters would need to exert four diopters of accommodation when fixing a point requiring two meter-angles of convergence. These facts must be taken into account in the plotting of accommodation—convergence curves. This is done by starting the diagonal either above or below the zero mark taken for emmetropia.

Clinically, or in office practice, the foregoing procedure would be too technical and laborious. As a matter of practice, two points suffice, namely: 6 meters or 20 feet and 33 centimeters or 13 inches. If one test only is to be made it is desirable that the test at 13 inches be employed, since the functions of accommodation and convergence are both normally called into play at close points, while the accommodation and convergence responses at twenty feet are not so demanded but are normally nil or inactive except in so far as accommodative or convergence insufficiencies or excesses, required in the interests of binocular single vision at distance, enter in. In other words, the stimulus to accommodation is at its lowest when distant objects are viewed and convergence is nil, normally, at such points. As a result, it is to be doubted whether or not tests upon either the relative positive and negative accommodations or upon the ductions, particularly the adduction and abduction, are in the majority of cases of much value when the fixation point is at twenty feet or better. The duction test at distance constitutes a method of testing the ability of a pair of eyes, through the medium of the fusion sense, to prevent diplopia or, in other words, such tests are a measure of the power to maintain binocular single vision. However, this is a point open to discussion, and the writer would recommend that such tests be made as a matter of routine in eye examinations. Clinically, therefore, after having obtained the data on the relative accommodation at 6 meters, "it is insufficient," as Howe says, "to determine at once the amount of relative accommodation with convergence at three meters, namely, at about the reading distance." These tests may be made in a few minutes through the use of a phoro-optometer, such as DeZeng's, in which one wheel carries a series of lenses of + 2, + 4, + 6, + 8 and — 2, — 4 and — 6 in addition to the other wheel devices for getting quarter diopters.

Donders stated the important principle that "*The accommodation can be maintained for a distance at which, in reference to the negative part, the positive part of the relative range of the accommodation is tolerably great.*"

Howe devotes a considerable number of pages to this and allied topics in his two volumes on *The Muscles of the Eyes.* On page 339 of the first volume he writes: "In our studies of the conditions of the muscles we shall find the most important and apparently the most frequent anomalies are those which involve the ciliary muscle. Therefore, even in routine examinations, and at the first visit, it is desirable to determine whether the action of that muscle is normal or excessive, or insufficient. At least a general idea as to this power of the ciliary muscle is shown, as already stated, simply by placing thus a minus 3 glass before each eye and asking the patient to read again the distant test type. I have learned to regard *this as one of our most important tests.* For if, after the ciliary muscles have had a minute or two in which to adjust themselves, the person can still read as well as before, then we know at once, at least in a general way, that there is no imperfection in the power of the ciliary muscle, apart from convergence. If the person cannot overcome these or weaker minus glasses in proportion to his age or in proportion to his ametropia, then we may at once suspect some insufficient power of the ciliary muscles. Even when such insufficient accommodation does exist, there may be little or no discomfort at near work, especially if the extraocular muscles are exceptionally strong or the general condition or the occupation of the individual unusually favorable. But ordinarily, if the positive part of the relative accommodation is insufficient with parallel axes, and also with convergence at one-third of a meter, and if discomfort and headache do exist, then that clue should be followed up. The examinations should be repeated, at first roughly, if desired, with convergence at one-half or one-quarter of a meter. But if this evidence points in the same direction, then it is usually worth while to make the data complete by measuring the base line and going through at least the essential part of the examination indicated."

It is to be noted in passing that these tests are *binocular* in character. Certain it is that they do furnish much data of value in many cases—perhaps, it may safely be stated, in the average case in ordinary practice—yet it seems to the writer that it is a more logical procedure to engage in *monocular* tests, for the two eyes may be entirely different in their accommodative ranges and resources as well as visual acuities. For as Donders wrote, "It appears that in every one who has *two sufficiently equal and movable eyes* we may distinguish: (1) The greatest distance of distinct vision, (2) the shortest binocular distance of distinct vision, (3) the absolute distance of distinct vision with the maximum of convergence, (4) relatively shortest distances of distinct vision at each given convergence, and (5) relatively greatest distance

of distinct vision at each given convergence." Hence presumably "Two freely movable, accurately seeing eyes of nearly equal refraction and equal accommodating power are required." And again, if the eyes are corrected and their visual acuities made equal and the ametropias neutralized by glasses, the eyes by no means immediately become equal to emmetropic eyes of similar range of accommodation. In rebuttal, however, it may be stated that, unless there is direct proof to the contrary, the accommodative impulse and innervation is a binocular function irrespective of whether or not the overt act of accommodation is thereby actually accomplished in each eye separately; and as a result it follows that the significance of relative accommodation-convergence relations is not destroyed by virtue of the inequalities of accommodative range, resources or even visual acuity, the better eye simply being master of the situation. But it does appear to us to be a much more logical procedure, in the last analysis, to absolutely eliminate the presence of convergence from accommodative tests—and by convergence we mean that which should be written at all times in strict accuracy, binocular single vision—and to investigate the accommodation monocularly and to then, under the methods peculiar to the fusional tests, investigate the convergence *per se* as associaated with the accommodation. But it is to be said that while we may prevent the act of convergence in the sense of binocular single vision by the occlusion of one eye, still convergence as associated with the act of accommodation cannot be so interfered with. For it is possible, as the two extremes, that no convergence may be associated with the accommodative act or that the whole of the convergence or even an over-convergence may accompany the accommodative act. However, both methods—the binocular and monocular tests—are most valuable adjuncts in scientific refraction and either one, consistently practised, will lead to much more scientific work in ministering to the needs of the ocular economy. The analysis of all refractive cases should be made, in so far as possible, upon each function separately and then in coordination.

Dynamic Skiametry as an Objective Relative Accommodation Test.

We are now in position to return to the answering of the query: Is not dynamic skiametry, as practised with the use of fixation and observation at the same point, and lens quantities added until reversal occurs, simply an objective method of obtaining relative accommodations? We believe that it is. For if, as is the usual condition of affairs, the case is one of hyperopia, either simple or compound, and the subject under test fixes a point in the same plane as that from

which observation is conducted, and convex lenses are added until reversal occurs, then we have, in one sense of the word, an objectively determined counterpart of the negative relative accommodation. The question as to whether the patient reads or does not read the test card or types he is told to fix and decipher is not a test of the value of the method or the accuracy of the findings, since this is an objective test and simply furnishes data upon the relaxation of accommodation as *skiascopically* determined for the point fixed. For example, if a hyperope, as tested statically, can be made to accept + 1.00 D. S. with visual acuity approximating 20/20 and then, under test at thirteen inches, it is found that binocularly + 3.00 D. S. are needed to cause reversal, we are entitled from these skiametric findings to say that the relative accommodation is two diopters at the thirteen inch point, if we assume two things: (1) that there is no variation of importance in the techniques of static and dynamic skiametric tests and (2) that the hyperopic error—even suppose it corrected—as determined at distance is carried through at all close points without the possibility of there being a greater demand of energy to produce one diopter of accommodation at 13 inches than at 20 feet. Hence, if dynamic skiametry is practised with the idea of obtaining the lens quantities necessary for reversal at various fixation points, observation and fixation planes being the same, then we have objectively determined the *negative* relative accommodation at these various fixation points. In the case of emmetropia cited from Howe, the plus lenses overcome, with various amounts of convergence as subjectively determined by reading test types, were:

Meter Angle	+ Glass Overcome
0	0
1	0.75
2	1.50
3	2.00
4	2.25

By dynamic skiametry such a case would be likely to show the following data if the findings are taken to the *point of reversal:*

Meter Angle	Skiametric Findings
0	0
1	+ 1.00
2	+ 1.75 or 2.00
3	+ 2.25 to 2.50
4	2.75

Hence the dynamic skiametric findings will vary under the procedure of obtaining reversals at various fixation points and constitute

fundamentally a means of obtaining relative accommodations and are not indicators, *per se,* of the lenticular assistance demanded in order that the accommodative demands or, again, the coordination between accommodation and convergence may be met.

The same is true in cases of myopia. A case of myopia, demanding — 2 D. S. for correction at six meters, might show perchance the following:

Meter Angle	Skiametric Findings
0	— 2.00
1	— 1.75
2	— 1.50
3	— 1.00

These data should be interpreted as showing that at 20 inches there is a negative accommodation of half a diopter and at thirteen inches of one diopter if the findings are recorded as obtained at the reversal condition.

Lag of the Accommodation Behind Convergence.

However, we feel rather positive from a long series of tests by various modified methods of skiametric testing, that there is always a *lag,* skiametrically considered at least, *of the accommodation behind the convergence.* By this we mean that eyes practically emmetropic as far as any static or subjective tests could determine, possessed of plentiful amplitude of accommodation, fusion powers and reserves ample—in other words, as nearly physiologically perfect as could be found—have demonstrated to the writer the fact that small convex lens quantities are always accepted skiametrically, fixation and observation being in the same plane. These convex lens quantities usually remain constant irrespective of the distance of the fixation point and amount to practically half a diopter to three-quarters of a diopter before neutrality of shadows is obtained. Another method of testing is to take an emmetropic pair of eyes and have them fix a very small letter on a quarter inch fixation card held on a thin rod and to then determine the point of neutral shadow skiametrically. In such emmetropic eyes, or those which have been artificially rendered so, in so far as refractive errors are concerned, for some time, we have found that the neutral or reversal point is slightly farther from the patient's face than the fixation point, irrespective of the position of this point. We have designated this as a *normal lag of accommodation.* If this condition is universal and is not much affected by the nature of the error—and for some reasons we believe that it should not be and from other view-

points we are not so certain—then we should expect all dynamic findings skiametrically to be slightly greater at close points in hyperopia and slightly less at close points in myopia as compared with the static skiascopic findings. We feel that this is an important point of variation in the technique and interpretation of the dynamic skiametric procedure as compared with the static method.

Such a test as the foregoing may be quickly made by putting a few small letters on a strip of card about a quarter-inch wide and attaching to a fixation stand or inserting in a small carrier attachable to the phorometer rod. With the nearest emmetropic and otherwise physiologically normal eyes under test the neutral point skiametrically may be found with various fixation points, such as 20, 13, 10, etc. inches. These values, converted into dioptric equivalents, represent the normal lag of accommodation behind fixation. A sample set of data is the following:

Skiametric point of reversal (inches)	Dioptric value of reversal point	Patient's fixation point	Dioptric equivalent of fixation distance
15	2.6	13	3
12	3.3	10	4
10	4	8.5	4.7

This important observation does not appear to have been recorded by others and is of considerable significance if it proves to be correct in all particulars.

A corroborative proof of this claim may be obtained by a method to be discussed in another section having to do with an objective method of finding the amplitude of accommodation. If an operator, working with fixation and observation at one meter, adds lens quantity sufficient to produce neutral shadows at one meter, and then advances both observational and fixation points to thirteen inches, for example, demanding thereby three diopters of accommodation, then it will generally be found, either by a monocular or binocular test, that the movement of the shadow will be "with" (using the plane mirror) and that the fixation point must be kept constantly slightly inside of the skiametric observation point in order to obtain a neutral shadow. There is, therefore, evidently a physiologic lag or relaxation of the accommodation amounting to about half a diopter at 13 inches. We are not prepared to say that this lag does not change with the distance of fixation. In fact we believe that it increases at a slow rate with increase of convergence, probably changing from about a quarter to a half a diopter at one meter to three-quarters to one diopter at eight inches.

If the foregoing statements are correct, then it seems that the only correct procedure in obtaining the relative negative accommodation objectively is to determine experimentally, by some skiametric process, the lens quantity necessary for reversal and to subtract therefrom about a half diopter in cases of hyperopia and emmetropia and to add thereto a half diopter in cases of myopia.

An Objective Test of Positive Relative Accommodation.

It has been shown that dynamic skiametry may be used as an objective method of determining the negative relative accommodation at various fixation points, the fixation and observation points being the same, and the lens quantities changed until reversal occurs. The question naturally arises as to whether or not there is any objective method of finding the positive range of relative accommodation at various distances of fixation. Strictly speaking, the answer is, No. However, some interesting tests can be applied and results obtained on the range of positive accommodation. Considerable skill and patience are generally necessary, and the writer has found that these tests again indicate that skiametric determinations show that the amount of accommodation which should mathematically be demanded and delivered does not appear to be physiologically forthcoming; or, again, there is something of a lag, not in the sense of slowness or sluggishness of operation of the accommodative function from the *time* element standpoint but from the viewpoint that a subject, when endeavoring to read the material upon the fixation stand, does not have to produce dynamically the exact equivalent of the concave (minus) lens inserted before the eyes. To illustrate: Assume an emmetropic condition at infinity which requires, let us say, + 0.50 D. S. to give neutral shadows at thirteen inches. If — 1 D. S. are slipped in front of both eyes and observation and fixation points are kept constant at 13 inches, then it will be found that the shadow will be "with." However, if the observer will back away slightly there will be found a neutral or reversal point, perchance at 15 inches, for example. If neutral shadows had been obtained at the same fixation and observation point after the insertion of the — 1 D. S., then we should say that exactly 4 diopters of accommodation had been exerted, since 3 diopters would be demanded at 13 inches and 1 diopter of accommodative action to overcome the additional — 1 D. S.; as a matter of fact but 3.66 diopters are delivered. By continuing this process it is found that, in order to obtain neutrality, skiametrically, as the amounts of minus spheres are increased, the observation point recedes very slowly, i. e., by inches, until finally the ciliary is unable

to produce the crystalline changes necessary to neutralize the added concave (minus) lenses. At this instant the shadow will be "with" and no reversal point can be found, since the ciliary, having ceased to function no longer approximates the neutralization of the added minus glasses.

Hence the writer feels that all of these tests demonstrate that the act of accommodation is not physiologically as exact as would seem to be indicated by the ability of the person under test to read certain sized types at various fixation points through various quantities of convex and concave lenses. Such a fact—if such it is—does not destroy the usefulness of our various relative accommodation tests but does point out to us the necessity of care in the interpretation of results as obtained by different methods.

Dependence and Independence of Accommodation and Convergence.

The next query which arises is: How dependent and how independent are accommodation and convergence? The relative accommodation-convergence tests, as obtained by the subjective method at least, indicate clearly that there is some dependence and some independence. For, in general, in a particular pair of eyes, a certain amount of convex and concave lens quantity may be added before inability to see clearly occurs while convergence remains constant and binocular single vision exists. We furthermore know that, accommodation remaining constant, the convergence may be investigated as to its positive and negative amplitudes at any fixation point through the use of prisms base in and base out respectively. The question is sometimes asked: Why will not an emmetrope, reading at 13 inches, accept + 3 D. S. and that gladly? We know that they will not unless there is absolute paresis of the accommodation or natural presbyopia. The answer commonly given is that the convergence act is normally associated with the accommodative act and that a disturbance of one of these functions will interfere with the other. But investigations show that the amount of plus lens quantity through which various youthful emmetropes,—as determined through various static tests,—of about the same age, can read without discomfort or blurring varies considerably. Hence the logical basis of explanation of dynamic skiametry as practised by obtaining reversal of skiametric shadow is the dependence and intimate relations of accommodation and convergence. True it is that the normal pair of eyes accommodates 1 D. in each eye at 1 meter and that the average pair of eyes converges at the same point 3△ for each eye. Hence, we find the statement commonly made in our textbooks that the accommodation and convergence relations

at all finite points are in the ratio of one to three, as an average. The exact mathematical relation can always be obtained from a measurement of the P. D. These are facts, and it cannot be denied that a normal or standard pair of eyes should accommodate and converge in the ratio of one to three in order to give distinct binocular single vision. But we are certain that a fallacy exists in the minds of most thinkers and readers upon this subject because this statement of mathematical fact does not have anything to say as to the *source* of the convergence innervation. Except in a few rare and very abnormal cases we have seen, we are in agreement with Savage when he writes: "Whatever may be true of other associated brain centers, it appears that the center of the ciliary muscles and the third conjugate innervation center (convergence center) can have the associated impulse run in only one direction: that is, from the former to the latter." Hence convergence cannot, except rarely, induce accommodation. But it is not true, as we hope to prove in other paragraphs, that all the convergence impulse must and does occur in conjunction normally with the act of accommodation. For it can be demonstrated that there are two sources of convergence possible and usable for obtaining binocular single vision, namely: *accommodative* and *fusional* or *supplementary.* By dissociation tests, through the use of prisms base up and down respectively before each eye, binocular single vision can be prevented and the amount of convergence as associated with the act of accommodation at any distance from the eyes can be determined. The difference between the amount of convergence demanded mathematically at any point and the accommodative convergence developed at that point is a measure of the demand upon the fusional or supplementary convergence at that point. The amounts of accommodative convergence vary greatly in different individuals: it may be nil (assuming orthophoria at distance) as the one extreme and, as the other, there may be any amount of overconvergence associated with the act of accommodation. Hence we are unable to tell through what channels the convergence act is accomplished when binocular single vision obtains unless we analytically find out by eliminating the element of fusion from our tests. The convergence-accommodation relationship for distinct binocular single vision may, therefore, be three to one in various cases, but all of the convergence may come through the innervation associated with accommodative channels in one case and none through the fusion, whereas in a second instance, none may come through the accommodative channels and all be supplied through innervation from the fusion centers. As a result the intimacy and dependence of accommodation and convergence must rest, in part at

least, upon the manner in which binocular single vision is produced.

As we understand his writings, A. Jay Cross—the originator of a considerable portion of the technique of the practices commonly referred to as dynamic skiametry—evidently holds to the theory of the normal three to one ratio between convergence and accommodation, believing that normally at 13 inches there should be 3 D. of accommodation in each eye associated with 9 △ of convergence accompanying the act of accommodation, thereby insuring at once *distinct* and *single* vision without the necessity of supplementary energy. Such a condition may be mathematically ideal, but we have to say that we rarely find it fulfilled and hence do not believe it to be the normal condition of affairs.

In order to present various views upon this topic we quote several paragraphs from Cross *(Dynamic Skiametry in Theory and Practice)*:

"To illustrate the value of this method, and also to show its practical adaptation, a case will be considered whose error of refraction is two diopters of hypermetropia, one diopter of which is manifest, and one diopter latent, or in a condition somewhat spasmodic. In examining this eye at a distance of forty inches, the patient looking at some object twenty or more feet away, it is found that the static method shows one diopter of hyperopia, as it takes a two-diopter convex lens to produce a reversal of the shadow at this distance, one diopter of which represents the artificial myopia, or the working refraction required. The dynamic method being used in this case, it is discovered that when the patient looks at the fixation card, forty inches away, a convex lens of a diopter and a half can be added before a reversal of the shadow is obtained, the examiner then advances so as to make the test at a distance of thirteen inches and find that two diopters can be added before reversal takes place. Advancing to within ten inches of the patient's eyes makes no change. Withdrawing to forty inches again, it is found that very little alteration in appearance of the shadow has occurred unless the patient has looked away in the meantime, when the spasm will most likely reassert itself."

"Now what has taken place? The accommodation called for by the dynamic method at forty inches was one diopter. The patient having two diopters of hypermetropia had, therefore, to make a total accommodative effort of three diopters, in order to see the letters on the fixation card. The examiner supplies refractive assistance until one diopter and a half of convex lens quantity has been added, the accommodation relaxing to this degree and the shadow showing a reverse movement. Perhaps this case is one where the age of the patient is less than twenty years, general health considered good, and muscle

tension, or unconscious habit of exertion, is suspected of being vigorous. A new test is made at a distance of thirteen inches where the total accommodation called for is five diopters, of which two represent the hyperopia and three the amount called for in emmetropia at this distance. Under this burden the eye will be found to accept a two-diopter convex lens quantity before reversal occurs. Repeating the test again at ten inches no more relaxation is found, thereby proving the second finding to be correct."

"To analyze still further, it may be stated that at thirteen inches, where an emmetrope uses three diopters of accommodation, nine degrees of convergence are called for. A patient, therefore, who is making five diopters of accommodative effort, ought, correspondingly, to make fifteen degrees of convergence, thus calling for a distance of eight inches."

"So, as before stated, while both accommodation and convergence seem somewhat elastic, they, nevertheless, appear to have a tendency to attain a standard co-ordination when disturbing factors are removed."

"The following examples, too, may show the application of some of the more important points: When an eye looks at an object situated forty inches away it must exert its accommodation at least one diopter. Place a plus one-diopter spherical lens over this eye and if it is emmetropic the emergent rays will converge at a point twenty inches away. One diopter will then represent the accommodation and one diopter the trial lens, or artificial myopia, making a total of two. If a plus two-diopter lens is used, the point of convergence will be at thirteen inches; if a plus three-diopter is employed, it will be at ten inches; the accommodative myopia increasing the total myopia."

"Now suppose a patient has an error of two diopters of hypermetropia, then what occurs when a three-diopter lens is added? Why, the accommodation under the stress of carrying a burden immediately surrenders its error, readjusts its accommodation and convergence to a relationship of least resistance, and there is left only one diopter of what we call artificial myopia, and one of accommodation myopia. The point of convergence of the emergent rays would then be at twenty inches instead of at ten inches, which would be the point of crossing of the rays from an emmetropic eye under the same conditions of lens and accommodation. Therefore it will be seen that where the rays ought to cross is at ten inches, and where they do cross is at twenty. The difference in ray value being two diopters—the amount of the error."

"In cases of this kind it is only natural for a student to ask why

an eye under these conditions does not surrender more than two diopters, especially when it is exerting its accommodation one diopter for fixation. In reply it can be said that, without compulsion, an eye which is making three degrees of convergence will naturally try to make one diopter of accommodation in order to maintain the harmony of the theoretic standard of one to three relationship. This explanation can also be given to account for the discomfort an emmetrope of, say, twenty years of age, experiences when attempting to read at thirteen inches distance with a pair of half-diopter plus spheric lenses on; his accommodation and convergence will not be in accord. The convergence required at thirteen inches is nine degrees, which calls for a co-ordination of three diopters of accommodation, but try to reduce this accommodation by even a quarter-diopter and the harmony will be disturbed, causing discomfort to manifest it."

"In true myopia, of one diopter, similar conditions of ray and fixation values are present, one diopter for accommodation at forty inches, and one for the true myopia, make two, the ray value of which is twenty inches. In all pronounced errors of refraction an examiner must ever bear in mind that the relationship of one to three between accommodation and convergence may have been upset and a different co-ordination established. Measurements in myopic cases frequently vary under ray and lens value procedure, but while skiametry always gives the refraction exactly as it is under the existing conditions, these conditions may be such as to trouble an examiner in the formation of his judgment. Hence measurements taken in different ways are productive of better results."

Monocular and Binocular Tests.

We are not, however, in accord with the Cross theory or method of interpretation or use of dynamic skiametry. Its fallacies consist, according to the writer's notions, in the following: (1) The values of the corrections obtained at any fixation point (observation and fixation being the same), when reversal of shadows is obtained, is not a measure of the *accommodative need* in order to correlate accommodation and convergence, but is a measure of the *negative relative accommodation.* (2) The co-ordination or correlation of convergence and accommodation is mathematically, for the average pair of eyes, about three to one, but there is no evidence that all, a part, or none of the convergence is obtained as an accompaniment of the act of accommodation unless tests investigating these relations are made. On the other hand, we do believe that the findings as made by dynamic skiametry in contradistinction to static skiametry are of

considerable value if modified to the extent that lens quantities are added, observation and fixation points being the same, until *neutrality* of shadows occurs. This, then, is a simple method of finding out what an eye or eyes (at any fixation point and accommodating therefor or endeavoring so to do) will gladly accept. Furthermore, we do not feel that the dynamic skiametric method is a *binocular* one necessarily, although it may be. Whether or not it is binocular or monocular depends upon the function of convergence, its source and the demands upon it. If none of the convergence is associated with the accommodative act, then we know that binocular single vision at thirteen inches, for example, is accomplished through the delivery, for the average pupillary distance, of 18 △, which must come through the fusion channels. As a result, therefore, any relaxation of the accommodation or any dynamic act of the ciliary in producing accommodation, would neither *decrease* nor *increase* the convergence, since none of this comes in association with the act of accommodation. Hence the dynamic skiametric findings in such a case could best be considered as *monocular* and as being simply a measure, at the point of neutral shadow, of the lens quantities accepted by an eye in the interests of comfortable seeing. But, on the other hand, we may have an ocular condition of affairs which, when analyzed under the dissociation test, will show that all of the convergence, or perchance too much convergence, in order to obtain binocular single vision is associated with the accommodative act at close points. If such a pair of eyes were examined by the methods of dynamic skiametry at near points, such as the usual reading distance, *with one eye occluded,* then the function of binocular single vision would be destroyed and, therefore, while the convergence associated with the accommodation would be still operative, the findings by dynamic skiametry could not be taken as either an objective method of determining relative accommodation or as a measure of the accommodative needs at the point under test. However, assuming the same conditions of accommodative over-convergence or latent convergent squint, when both eyes possess about the same refractive errors and have equal powers of accommodation, and when both eyes are open to test and engaged in the act of binocular single vision or the attempt to obtain it, then the test may be strictly said to be a *binocular* one, since the acceptance of convex lenses will reduce the accommodative innervation and act and thereby inhibit accommodative convergence. In such cases as this, considerably greater convex lenses will ordinarily be accepted than when one eye is occluded or when the static skiascopic findings are made with both eyes passively fixing a distant object. Evidently this condition

does constitute a very dependent correlation of accommodation and convergence and the suppression of one function causes a suppression of the other. It is for this and similar reasons that the writer believes that dynamic skiametry, *per se*, can only afford some sort of an answer as to the accommodative needs at close points and that it does not sufficiently analyze the case. However, the obtainance of such data by such methods is far better than no data, but if these tests are supplemented by other tests on accommodative convergence, fusion convergence demanded, and fusion convergence reserves, there is then provided a scientific method for the determination of those lenticular or prismatic quantities which will adequately serve the eyes when engaged in close work. From this it is to be inferred that dynamic tests, *in toto*, at close points furnish, in large measure, data of value chiefly for reading and close working lenses, although they often furnish data which show the examiner that greater convex lens power should be prescribed for general wear irrespective of whether or not the visual acuity is decreased or, perchance, not raised to as high a value as possible.

It is pertinent to briefly discuss the effects of hyperphoria, i. e., vertical imbalances, of such amounts as to prevent the act of binocular single vision or to so tax the recti muscles and their innervation centers as to cause this act to be performed with difficulty. Such conditions of lack of vertical orthophoria may readily either dissociate the two eyes or else induce derangements of convergence. Hence, if there is an intimate connection between the accommodative act *per se* and the convergence, such relations may be modified because of large vertical imbalances: hence it is logical to see to it that any appreciable hyperphoria is corrected by prisms base up and down respectively, so that the eyes under test dynamically at close points may be enabled to accommodate and converge under the most advantageous circumstances. Such imbalances may affect in large measure the value of these tests.

Sheard's Method of Using Dynamic Skiametry.

In his own practice the writer uses dynamic skiametry, as a general rule, with observation and fixation at the point selected by the person under test as being the usual reading or working distance point, and then proceeds to determine the lens quantities necessary to produce neutrality of shadows. This gives, as he interprets his findings, some indication of the accommodative assistance demanded at this point under the conditions of convergence,—i. e., whether the convergence necessary to binocular single vision be accommodative, fusional or a

combination—which actually exist, without any information as to the results indicating monocular or binocular findings *per se.* Since, in addition, he believes that there is a normal lag of accommodation of about half a diopter on the average, this amount must be subtracted from the findings in hyperopia and added to the findings in myopia. If these findings are comparable with the static skiametric findings—which, by the way, are most abominably and unscientifically made by the average practitioner—then he is justified in the conclusion that static and dynamic findings are in agreement and that the function of accommodation is adequately served, that there is little latent error or spasm of accommodation, and so forth. For instance, if static skiascopy gave O. U. + 1.25 D. S. and the dynamic methods for neutral shadows at 13 inches gave O. U. + 1.50 D. S. to + 1.75 D. S., this would be accepted as fair evidence of the probability that O. U. + 1.25 D. S. or thereabouts would adequately serve these eyes. But if the dynamic findings were in radical disagreement with the static skiascopic data, then a condition of presbyopia, subnormal accommodation, latent hyperopia, spasm of accommodation or latent convergent squint might be suspected. For example, if static skiametry gave O. U. + 1.25 D. S. and the dynamic findings gave O. U. + 3.00 D. S. for neutral conditions at 14 inches, there would be suspected one of the conditions just cited, and the operator would proceed to carefully investigate the case.

There may be and doubtless are ocular conditions in which dynamic skiametry fails to give data of much value. In high anisometropia, for example, it may happen that one eye will carry on the function of vision at the reading point, the vision in the other eye being suppressed and not functioning, hence dynamic findings on the fixing eye would be of value but of no significance with respect to the non-fixing eye. Such a condition is likely to arise when one eye is hyperopic and the other myopic. But again, in a case of anisometropia in which both eyes are hyperopic but one much more so than its mate, the act of binocular single vision may be enforced and accommodative action take place in each eye to the same extent. Then the dynamic findings on these eyes will be equally valuable in the determination of the lenticular assistance that each eye needs at the point of fixation.

As the result of experience, the writer generally obtains the static skiametric findings first, knowing that thereby he has found a correction, to the first order of approximation, to say the least, that will place the eyes in as nearly a normal condition statically as possible. He then leaves in temporarily the *spherical* elements determined upon, in addition to the + 1 D. S. used for the working distance

skiascopically, and then has the patient fix a set of small letters on the mirror held at the patient's usual reading distance. This affords a rapid method of finding neutrality of shadows at this distance because, in the majority of cases, it is found that neutral shadows will be obtained almost immediately: if not, increase or decrease of lens quantities can be quickly made to affect neutral conditions. Cylindrical correcting lenses are removed in the dynamic determinations for reasons to be stated in the next chapter. In myopia we may proceed in the same manner and quite frequently do, but as often we start with no lense quantities before the eyes, using fixation and observation at the same distance, and add concave (minus) lenses until neutral shadows are obtained.

Since the majority of refractive cases are those involving hyperopia and since the greater portion of such cases evidence about the same amount of error in each eye and develop, under test, equal accommodative ranges and amplitudes and, furthermore, since the vertical imbalances *per se* are generally not of sufficient amount to interfere with the function of binocular single vision, it follows that dynamic skiametry is a valuable tool in the hands of those practitioners who will take the time to think upon these matters and put them intelligently into practice.

Chapter III. Some applications and advantages of dynamic skiametry.

It is doubtless true that no other method in the examination of the eyes requires greater practice to successfully master and interpret in all its details than does skiametry. It may also be added that the dynamic method requires greater skill in order to read and interpret the shadow's action than does the static method. The reason for this is found in the consideration of the matter of retinal illumination, for it is a well-known fact that the shorter the distance between the light source and the patient's eye, the larger and brighter will be the area of illumination on the fundus of the eye under examination. This fact, taken in connection with a study of the optical laws governing penumbra (shadows) and the variation in retinal pigmentation, together with the size of ocular pupils and the action of the light stimulus, show that the nearer the eye a skiametric test is made the more difficult becomes the determination thereof. However, as in everything else, practice makes perfect, and ultimately the operator may readily carry out the methods of dynamic skiametry in a fairly well-lighted room without much difficulty. In order to give a sug-

gestion to those who have never tried this method, or have acquired no proficiency, let it be suggested that a very favorable reflex may generally be obtained by placing a separate fixation stand at about a meter from the eye and then making the first skiametric observation from a point about two inches to the right or left side of the card—the operator should learn to use either eye in these skiametric examinations—and an inch or so nearer the patient. If a "with" motion is present, add plus spherical lenses until the motion or shadow becomes neutral, as the writer practises the system, or reversed according to the methods of Cross.

Small Pupils.

All skiascopists realize the inaccuracies in skiametric work when large pupils are present. Physically, of course, the peripheral refraction is commonly different than the central refraction; in other words, spherical aberration is present. There are those conditions of decided "against" or myopic shadows under the methods of fixation and observation peculiar to static skiascopy in which there is a small, indistinct "with" or hyperopic movement in or near the line of vision. This latter is the portion which should be refracted. As a result, skiascopists would, if given their choice in the matter, prefer smaller pupils in general, since there would be the riddance of irregular refraction due to slight thickenings of corneal tissue, etc., and uncertainty as to what constitutes the real error. Refraction under cycloplegics, whether objectively or subjectively made, suffers and is in error by virtue of the fact that the relaxation of the ciliary, which is so desirable, is also accompanied by dilatation of the pupil. In such methods, therefore, the most scientific procedure would be to use an iris diaphragm in conjunction with various subjective and objective tests, thereby artificially producing a pupil nearer the size of the normal pupil. Therefore, with accommodation and convergence at close points and the added stimulus of retinal illumination, the dynamic skiametric examinations quite frequently afford definiteness as to the principal refractive errors, eliminate the peripheral refraction and tend to disclose the refraction along the line of vision. In passing, the writer states as the result of his experience and observation that the average skiascopist, working by the static method, overestimates myopia and underestimates hyperopia by as much as half a diopter.

Refraction in the Direct Line of Vision and the Elimination of Scissor Movements.

In static skiascopic tests as usually conducted, the patient's gaze as to his right eye is directed over the operator's right shoulder and

over his left for the left eye. The portion of the retina thus made conjugate to the point passively fixed, due allowance being made for the working lens quantity, is not the same as is made conjugate to the observer at this working distance; the same retinal portion, namely the macula, is not involved in the subjective act of passive vision and the skiascopic observation of the operator. In other words, the objective refraction is not determined along the visual axis. We cannot assume a uniformly curved or spherical retinal surface, (the fovea is known to be a slight depression in the macular area) hence objective findings may differ considerably when the light spot upon the retina falls at or remote from the fovea. The vital point is, therefore, that the skiascopic findings are not ordinarily made along the visual axis and hence many irregularities, due to obliquity of lenses, non-macular conjugate point, and so forth, may arise and disagreements between objective and subjective methods result because of lack of proper precaution in knowing the conditions under which each is carried out.

Several devices, some simple and some more elaborate, have been devised by Eberhardt, Herbin and Armbruster, to permit of skiascopic testing very close to the fovea centralis. These devices may be called "macular reflectoscopes" for want of a better name. Their fundamental advantage is that static skiametry may be practised with the assistance of such an instrument in a manner to permit of the patient definitely fixing a letter or other object while the skiametric refraction is made along the visual axis. The possibility of incorrect findings is thus reduced to a minimum. *Dynamic skiametry* permits of macular refraction without the use of any auxiliary device.

Scissor movement is a form of irregular astigmatism and is of sufficiently frequent occurrence in skiametry to warrant a brief discussion. In general terms, the skiascopic shadow is split into two portions which, as the mirror is rotated, advance from opposite sides of the pupil and merge into one band, giving the effect of the closing of a pair of scissors. Scissor movements may be due to a genuine tilting of the lens or lack of proper alignment of the various surfaces of the ocular media prependicular to the optic axis. In such cases scissor movements may be due to coma on account of the obliquity of one or more surfaces of the dioptric media to the path of the incident light. This hypothesis is substantiated by the following facts: (1) an eye having a normal reflex by direct illumination, the scissor movement may be obtained by directing the beam of light obliquely, (2) a tilted spherical lens, especially if of fairly high power, in front of an eye may produce such an effect, and (3) the effects can be produced

with schematic eyes and obliquely directed light. It will be found, therefore, that many of these conditions of scissor movement are not physiologically present but are due to physical defects in the manipulations of static skiametry. Dynamic skiametry, with its refraction along the visual axis, or static skiametry, with the use of the macular reflectoscope, enables one to avoid these defects and to be positive of their physiological existence if they occur. Furthermore, by dynamic skiametry there will often be disclosed with great certainty which portion of the reflex includes the visual axes.

Astigmatic Conditions.

Irrespective of our opinions as to the correctness or incorrectness of the spherical elements determined by dynamic skiametry, it is to be admitted that this method affords an excellent and rather accurate method of determining the amount of astigmatism. Where small amounts of astigmatism are uncertain by static methods it is generally true that they are discoverable by dynamic skiametry. And surely quarter diopters of astigmatism are worthy of attention and ought to be corrected if actually present, and omitted if not truly present. When the amounts and the axes of the astigmia do not agree with the static or subjective findings there are then presented those differences in ocular data which enable the practitioner to ultimately find the real errors.

All readers of these pages are aware of the rather pronounced differences met with in the data obtained subjectively, skiametrically and ophthalmometrically, upon the condition of astigmatism of an eye. Many physical and physiological reasons can be given to show why the ophthalmometric measurements, which give data upon the cornea only, should not indicate conditions of astigmatism in agreement with subjective and retinoscopic findings. And subjective and skiascopic findings may differ for various reasons (*vide* Sheard: *Physiological Optics*). The variations of *amounts* of astigmia can be accounted for more easily than variations in the apparent *positions* of the principal axes. Cases arise in which static skiascopic and subjective tests, conducted at twenty or more feet, disclose the axis of astigmatism at 90°, for example, when the ophthalmometer shows the axes at slightly oblique positions, such as 80° or 100°. Furthermore, it often occurs that ophthalmometrically determined axes agree better with dynamic skiametric findings than with the monocular determinations obtained by either static skiascopic or subjective methods. As a result the writer is not convinced by any means that binocular activity is as nearly suppressed when the ophthalmometric findings

are made as in monocular subjective and static skiascopic testings. For the end of the telescopic tube of the ophthalmometer is fairly definitely fixed monocularly and, while its mate may be under cover, there is still a considerable amount of binocular activity and convergence under conditions as ordinarily found. Experience has tended to indicate that ophthalmometric axes in cases of oblique astigmia agree better with dynamic skiametric or binocular findings than with monocular findings obtained by either of the static methods. This would seem to indicate that differences between ophthalmometric and skiascopic or subjective monocular findings as to the positions of the axes of the correcting cylinders may be attributed in part at least to the fact that in the first named set of findings binocular functions are more active than in the latter named tests. It is probable that there is no absolute monocular method of refraction in the sense that the normal desire for binocular single vision is temporarily annihilated and the involuntary activity of the binocular functions wholly suppressed, but certainly static skiascopy and distance subjective tests should approach this monocular condition most closely. While one eye is closed and the other is passively fixing at twenty feet, the conjugate centers are surely very inactive: when both are engaged in binocular vision at distance or at near points it is possible that various coordinating centers may be active. Certain it is that the divergence or convergence centers may be called upon to act in the interests of binocular single vision. There is no reason to believe, therefore, that in binocular vision innervation may not be demanded to maintain parallelism of the retinal axes and the median plane of the head. And even if conditions of orthophoria exist at distance, there is no *prima facie* evidence that such conditions exist at near points. There is no more reason for believing that the axes of the cylindrical corrections should not be shifted or changed slightly, as compared with distance findings, when the eyes are engaged in close work, than there is that the spherical elements should not be changed by virtue of the findings given by the two sets of tests (near and distance) because of difficult or subnormal accommodation, excessive convergence as associated with accommodation, and so forth.

We quote the following portion of a paragraph from Savage's *Ophthalmic Myology* (second edition, page 110): "Should the plane" (i. e., the horizontal plane of the head) "be inclined five degrees, the vertical axes of the two eyes must be inclined through the same arc, toward the side of the lower eye. This would be effected by activity of either the eighth or ninth conjugate center, on the superior oblique of one eye and the inferior oblique of the other. With one eye

covered, as in the work of refraction, the conjugate center would cease its activity and the eye would then have its vertical axis normally related to the median plane of the head. On uncovering the eye, the two vertical axes would be tilted again toward the side of the lower eye. The practical point growing out of this observation is that such eyes would require the shifting of the axes of the correcting cylinders toward the side of the lower eye through arcs corresponding to the lateral displacement of the horizontal retinal meridians."

The influence of mal-attachment or mal-functioning of the extrinsic muscles of the eyes engaged in binocular single vision upon their torsional equilibrium and consequent positions of cylinders correcting astigmatism in the interests of improvement of visual acuity and the establishment of conditions contributing to the most economic operation of the visual functions has been the subject of comprehensive treatises by Savage, Stevens, Howe and others.

As an illustrative case we cite that of a woman who had suffered all her life from ocular discomfort and who had not been able to do much if any near work. *Static skiascopy* disclosed O. U. + 0.50 D. S. $\supset$ + 1.25 ax. 90 and subjectively these lenses gave normal visual acuity. She was wearing a distance correction which, in the light of the acuity and muscular poise tests at twenty feet, was judged by us to be satisfactory. *Dynamic skiametry,* with fixation and observation at thirteen inches, indicated O. D. + 2.50 D. S. $\supset$ + 1.25 cyl. ax. 75 — 65°, and O. S. + 2.50 D. S. $\supset$ + 1.25 cyl. ax. 105 — 115°. The ophthalmometric findings showed the axis at 80 and 100 degrees respectively: a case affording evidence of the fact that the ophthalmometric findings, in which of course only corneal astigmia are disclosed, agreed better with the dynamic than the static findings as to the positions of the correcting cylinders. The tests at the reading point in the case under discussion were, therefore, made by initially inserting the spheres for reading as dynamically determined. The subjective tests were carried out at the reading point and the results binocularly with the cylinders at the oblique axes were decidedly better than with the cylinders in the positions statically determined and as statically demanded in the distance corrections. With these corrections before the eyes a test was made for the cyclophoric imbalances by the use of a double Maddox prism and a line of test type. A fair degree of minus cyclophoria was evidenced at the reading point and practically none at distance: in the latter case no corrections were inserted before the eyes. Following the Steele rules as laid down in Savage's *Ophthalmic Neuro-Myology* (*vide* also Savage: *Ophthalmic Myology,* page 406) this woman was given for reading O. D. + 2.25 D. S. $\supset$

+ 1.25 cyl. ax. 75 and O. S. + 2.25 D. S. ⊃ + 1.25 cyl. ax. 105. These proved eminently satisfactory. Such a case as this, to be sure, is not of common occurrence. As to the etiology of the rotation of the astigmatic planes or torsion of the vertical meridianal planes nasally or temporally we can only conjecture. As Savage writes: "A too high attachment of the interni or too low attachment of the externi would cause a minus cyclophoria, while a too low attachment of the interni or too high attachment of the externi would cause a plus cyclophoria. When there is a normal attachment of the interni, there can result from their action no cyclophoria." In the case at hand, we may believe from the evidence afforded that the interni were attached too high (or the externi too low) and that in the act of converging there was caused a torsion of the eyeballs about their antero-posterior axes, turning the upper portions of the vertical meridians nasally in each case and thereby throwing upon the inferior obliques a burden which they could not bear. The superior obliques would correspondingly be relieved from normal action.

E. S. McClelland, M. D., in a recent article, calls attention to the fact, as he believes it to be, that "The dynamic method of retinoscopy is the only satisfactory one for the correction of hyperopic astigmatism in children, because it eliminates the confusing and unimportant shadows of exaggerated astigmatism and other peripheral defects exposed by a fully dilated pupil, and also because it corrects an accommodated eye and not a relaxed one. Two things are of utmost importance in the correction of variable or hyperopic astigmatism in children, viz., a concentrated light of not less than eighty candlepower properly arranged and the eye to be corrected focussed for a meter's distance."

Use of Dynamic Skiametry in Presbyopia.

Cross (*Dynamic Skiametry*, pages 119-120) says of the use of dynamic skiametry in presbyopia: "Presbyopia is the one, so-called, 'easy' ocular condition that is often the most difficult of satisfactory correction, for the reason that occupation, illumination, habit, pupillary distance and innervation, or bodily vigor, are all factors to be reckoned with. Then, if combined with this the ignorance and stupidity of many patients in answering questions is taken into consideration, it is easy to see why changes in reading glasses are so frequent. * * * Up to the time of the development of the dynamic method of practising skiametry there was no known method of estimating presbyopia in an objective manner. All static methods, whether with or without cycloplegics, are solely for determining the refractive con-

dition of an eye when its muscles are in a state of complete relaxation, therefore the static method gives no definite aid in presbyopia whatsoever. Dynamic skiametry supplies the refractionist with a method that often proves of the very greatest aid in mastering a troublesome case, as it enables the eyes to be studied at all points, near as well as distant, this study being directed toward steadiness of convergence and accommodation, both of which can be detected through the use of a skiascope and lenses. As illustrative of this, suppose a case presents itself having a history of discomfort in reading, etc: the patient is directed to look at the skiascopic fixation card fourteen inches away while plus one diopter spheric lenses are before each eye. If the right eye shows a with motion while the left eye is against, it indicates either an error of refraction or an unequal innervation of the muscles controlling accommodation, notwithstanding that at infinity both error and vision seemed alike in the two eyes. The use of the mirror at this distance also enables the detection of any deviation in convergence of either eye when fixation for this point is maintained for a considerable time.

And again, there is no reason for believing that, in presbyopia, a certain specified amount should be added binocularly. So many practitioners simply slip, for example, O. U. + 1 D. S. before the patient's eyes while wearing the static or distance findings and fail to make any comparison as to equality of ability to read, or of range and amplitude of accommodation. There is no reason for believing that there is equality of accommodative amplitude of both eyes unless tests distinctly indicate it. When static findings indicate a difference of a quarter to a half a diopter in the two eyes, while skiametric findings at the reading point indicate the same spherical corrections for reading, the writer feels that we have an important and valuable indicator showing that the distance corrections have not (or else cannot be for some reason) properly made. For example, suppose that static skiascopy shows O. D. + 1.25 D. S. and O. S. + 0.75 D. S. subjective findings O. D. + 1.00 and O. S. + 0.50: dynamic skiametric findings O. U. + 2.00 D. S.: it is more than probable that full relaxation has not been obtained in the left eye or, if so, then the accommodative needs and amplitudes of accommodation are unequal. If the amplitudes of accommodation are equal, then the refractive assistance demanded as the fixation point is advanced closer and closer to the eyes should increase identically the same for both eyes; if the amplitudes are unequal, then the skiametric findings at closer points should show a greater lenticular assistance demanded by the weaker eye. The data afforded by such tests give

us information of much value in the fitting of a pair of presbyopic eyes.

Furthermore, it is always necessary to allow a portion—say one-half—of the accommodation to be kept in reserve and the other portion to be actually or actively used in close work. But the question is: How much in reserve and how much at work? Evidently each pair of eyes is a law unto itself. Other questions which must be answered before a satisfactory reply is forthcoming to this query are: Is there exophoria, or esophoria, or orthophoria (using the notation commonly used in such connection) at the reading point? Are the fusion reserves adequate? As a result of additional investigations on the convergence relations there may come a reasonably scientific answer as to the amount of presbyopic corrections. But the test by dynamic skiametry quickly and quite accurately indicates the lenticular assistance needed in presbyopia. From this finding, however, we feel that about half a diopter should be subtracted for reasons already given.

Subnormal Accommodation.

The abnormalities of accommodation that are quite frequently encountered include:

(1) *Insufficiency of accommodation.* The accommodation may be persistently below the lowest normal limit according to tables of normal accommodative amplitudes. This may be due either to undue rigidity of the lens or to weakness of the ciliary muscle. The first type may properly be called premature presbyopia. In the second type, due to pathological causes which may vary, the amount of abnormality may vary. The causes of this second type of accommodative insufficiency include toxic conditions due to infectious disorders, nasal obstruction, hypopituitarism, neurasthenia and anemia, exposure to light, and so forth.

(2) *Difficult or ill-sustained accommodation.* This condition is closely related to the condition specified above as insufficiency of accommodation. In fact, it constitutes the first stage of this condition for, while the accommodation may be normal in amount, it is sustained with effort and soon gives out. For example, a person may be able to read No. 2 Jaeger at thirteen inches through a —4 D. S., as a maximum, for a minute. Often, however, under such a test it will be found that the accommodative act cannot be sustained and reading may not be possible until a —1 D. S. is reached, showing a rapid sag in power to sustain accommodation. This condition of affairs is doubtless the seat of annoyance in the early presbyopic period.

(3) *Inertia of accommodation.* This constitutes a difficulty or

sluggishness in changing from one accommodative state to another. As a result accommodation is sluggishly relaxed in looking from close to distant points and print is not seen clearly and instantaneously when the gaze is changed from far to close points.

(4) *Inequality of accommodation.* The accommodation in the two eyes is not the same. This condition has been commented upon in writing of dynamic skiametry in presbyopia. The same statements made at that point with reference to the technique of testing such inequalities are generally applicable to all refractive conditions. In another connection different subjective and objective methods of determining amplitudes of accommodation will be given.

The inequality may be due to either greater weakness of the ciliary muscle or greater rigidity of the crystalline lens in one eye as compared with its mate. Ophthalmoplegia interna due to syphilis, tabes, poisons, etc., may be the cause: generally such inequality of accommodation is associated with inequality of pupils. When not due to the above causes the unequal accommodation is usually not associated with inequality of the pupils. Duane (*Archives of Ophthalmology,* 1915) writes: "In this case, too, it may be caused by unequal action of the ciliary muscles. This was evidently the case in one of our patients, a man of thirty-one, in whom the accommodation in the right eye varied from 3 to 4 D, in the left from 5 to 6 D, and who also showed marked fatigue of the accommodation in the right eye. The symptoms were great asthenopia and a marked spasmodic convergence when he tried to use his eyes for close work."

(5) *Excessive accommodation.* The accommodation persistently lies above the usual normal limit. Excessive accommodation due to ciliary overaction is the accommodative spasm produced by myotics. A similar action is set up naturally in some patients causing them to exaggerate a myopia or persistently to reject a hyperopic correction. Such a spasm may occur at any age up to fifty (or even beyond) and may be associated with an actual weakness of accommodation. The most important *subjective* symptoms of excessive accommodation include: (1) Sudden variability in vision in reading the test letters for distance vision, (2) changeableness and varying intensities or clearness of the lines on the fan or clock-dial chart, (3) the variability of the correcting lenses accepted by the patient and (4) the reported sensation of contraction or drawing in of the eyeball itself due to contracture of the muscles. The *objective* symptoms of accommodative spasm include: (1) The ophthalmoscopic examination shows the refractive condition of the eye to be considerably different from the glasses accepted on subjective testing, (2) the skiascope may show

decided variations in the refractive conditions and (3) in cases of astigmatism, the ophthalmometric and subjective findings may differ considerably.

Dynamic skiametry does not afford an analytical method of diagnosing the exact condition of classification in any of these divisions of subnormal accommodation. In fact, no one set of tests, either objective or subjective, will permit of such a differentiation, but all static and dynamic tests upon all functions, singly and in co-ordination, will generally give a correct solution to each ocular problem. But dynamic skiametry will quickly call attention to the probable normality or abnormality of the accommodative resources of a pair of eyes. If, for example, the static findings should be O. U. + 1.00 D. S., and the dynamic skiametric findings O. U. + 1.50 to + 1.75 D. S., we have fair evidence that the same refractive corrections will prove satisfactory, in so far as spheres or cylinders or their combinations are concerned, for both distant and close work. But dynamic skiametric findings do not give us information on the great body of ocular myological facts which ought to be possessed before we truly know the status of a pair of eyes. However, if the static findings indicate O. U. + 1.00 D. S., and the dynamic skiametric findings O. U. + 2.50 D. S., then we do have an objective indication of the need of additional convex lens power, at close points, to say the least, and this need may be caused by presbyopia, insufficient accommodation, spasm of accommodation, or inertia of accommodation. The dynamic skiametric findings in such unnatural or abnormal anomalies of accommodation (since presbyopia, *per se*, is perfectly natural) indicate the following methods of treatment:

(1) If the vision is blurred at near points, the distance glass should be supplemented by a proper addition for reading (presbyopic correction for an unnatural presbyopia). Practitioners of repute are adapting bifocal lenses to very young persons with eminent success in many cases.

(2) Even if the vision is not blurred much, if at all, except after long periods of close work, but where reflex symptoms are present, this presbyopic addition may be necessary, especially if there is an associated convergence excess. This wearing of bifocals by professional men and women, students and others of indoor occupations may be avoided by the use of two pairs of glasses, one pair to be used for close work only.

(3) The accommodation should be stimulated, when possible, by means of reading exercises, by means of approaching fine type toward the eyes until it blurrs with recessions and subsequent repetitions, and by exercising with concave lenses as proposed by Savage.

(4) In those cases in which there is considerable insufficiency of accommodation coupled with convergence insufficiency, it is well to exercise the accommodation and in addition to stimulate both convergence and accommodation by having the patient read a line of fine type through prisms, bases out, bringing the line of type closer and closer to the face.

Dynamic findings, taken in conjunction with subjective tests at the reading point, often indicate in presbyopes an excessive accommodation or spasm of accommodation still unrelaxed in the static skiametric or static subjective tests. Consider, for example, the following data: Mrs. McA. Aged 56 years. Nervously overworked and weak. *Static skiametry* showed O. D. + 3.00 $\bigcirc$ — 0.50 cyl. ax. 180, and O. S. + 2.50 $\bigcirc$ — 1.50 cyl. ax. 180, of which *subjectively* the following was accepted: O. D. + 2.00 D. S. $\bigcirc$ — 0.75 ax. 180, and O. S. + 1.75 D. S. $\bigcirc$ — 1.50 ax. 180. Visual acuity, as corrected above, O. D. = 30/50 and O. S. 30/30. With these subjective findings, however, O. U. + 3.00 D. S. had to be added before the patient could read with comfort any length of time, i. e., ten minutes. This makes the spherical corrections for reading O. D. + 5.00 and O. S. + 4.75. *Dynamic skiametry* at 13 inches gave O. D. + 5.00 $\bigcirc$ — 0.50 ax. 180 and O. S. + 4.50 $\bigcirc$ — 1.50 ax. 180, indicating that the subjective findings for reading were perfectly justified. However, at 56 years of age, normally there should be no need of the addition of O. U. + 3 D. S. for reading at thirteen inches, since this indicates paresis of the accommodation. The trouble lay, therefore, in the failure to obtain the acceptance of full corrections at distance. Other tests showed excessive tonic convergence at distance (7 △ esophoria) and overconvergence at the reading point. The remedy is evident in such cases: the difficulty is to exercise sufficient patience and care and to instil sufficient confidence and resignation in the patient to finally bring such a case as this to a happy solution.

In conclusion, the following brief citations of conditions not infrequently found in practice will be of interest.

Case 1. Quoted from Cross: *Dynamic skiametry.* "A case is reported of a young lady, fifteen years of age, who was behind in her school work. She had been atropinized and fitted with O. U. + 1 D. S. *Static skiametry* confirmed the prescription given. *Dynamic skiametry*, however, showed that a + 3.00 D. S. was indicated at thirteen inches. Plus 2 D. lenses O. U. worn for a month did not succeed in relaxing any more than the original correction for infinity. Bifocals of + 1 D. S. upper and + 3 D. S. lower gave almost perfect results after this form of glass had been worn for a few

weeks. * * * The indications were that this was a case of premature presbyopia or subnormal accommodation and dynamic skiametry was the only method by which it could be intelligently refracted.'' The last statement is to be doubted: if the statement had been written to say ''various dynamic tests were the only methods,'' then the writer would be in accord.

Case 2. Mr. W. Aged 20 years. Never worn glasses. Eyes smart when studying. Had scarlet fever 3 years ago. *Static skiametry* O. U. + 0.50 D. S. *Dynamic skiametry* O. U. + 2.00 D. S. *Tonicity tests* showed 1 △ esophoria and *accommodative convergence tests* at thirteen inches under the fusion dissociation test indicated 3 △ base out. The *accommodation* was found to be 6 D. in each eye, the patient wearing the distance corrections. Rx. O. U. + 1.25 D. S. for close work only. Vision reported comfortable at close work and all symptoms relieved.

Case 3. Mr. S. Aged 22. *Static skiametric* findings O. U. + 0.62 cyl. ax. 90. Subjectively, same findings, V = 20/20. Under homatropine the findings were the same. *Dynamic skiametry* gave O. U. + 1.50 D. S. ⊂ + 0.62 cyl. ax. 90, with fixation and observation at 13 inches, to produce neutral shadows. This finding evidences an accommodative need of about one diopter. Other tests on the *amplitude* of *accommodation* showed about 5 D. as a maximum. Patient complained of inability to engage in close work for any length of time. *Ophthalmoscopic* examination showed choroiditis in one eye and incipient conditions of chorio-retinitis in the other. Wassermann test positive. Hence the seat of the abnormal accommodation was disclosed.

Such cases as these demonstrate, however, that the dynamic method does not disclose latency of error or spasm, but rather actual accommodative needs at close points, since the findings under cycloplegics may not, as in this case, be as great as by the dynamic methods.

Case 4. Miss F. Aged 15. Inflamed eyeballs, watery eyes: headaches. Has had diphtheria, typhoid fever and scarlet fever within five years. Appears anemic and following the examination was referred for general systemic examination. *Static skiametry* gave O. D. + 0.50 D. S. ⊂ − 0. 25 ax. 180, O. S. + 0.50 cyl. ax. 90. *Subjectively* these were accepted with V = 20/20 binocularly and equally good. *Dynamic skiametry* gave O. D. + 3.00 ⊂ − 0.25 ax. 180 and O. S. + 2.75 ⊂ + 0.75 ax. 90. Patient could not read No. 2 Jaeger (V = 0.50 D.) type through the static findings or with naked eyes. With the dynamically determined findings she could read this type up to 7 inches. Other tests, however, showed that she possessed about 5

diopters of accommodation in each eye; certainly subnormal for a person fifteen years of age. A pair of glasses for general wear was prescribed and in addition for reading, school study, etc., a pair of + 1.75 combined with the proper cylinders. Under care and proper treatment affairs improved and after two months the accommodative amplitude increased a diopter. Further report cannot be made as the party moved into another state.[4]

In closing the chapter there is presented a summary of our main conclusions relative to dynamic skiametry and its service in ocular refraction.

(1) Data of value accrue to the practitioner through investigations by dynamic skiametry in which tests upon the coordination of convergence and accommodation, or simply upon the accommodative needs, to the enhancement of ocular comfort and economy while engaged in reading and other close work, are made possible *objectively.* The fact that static and dynamic results are not in agreement furnishes a basis for the determination of the proper assistance to be furnished in the interests of the dynamic functionings of the accommodative mechanism and, furthermore, enables the operator to inhibit excessive innervation, relieve weaknesses or to economically draw upon functions which are in strength to the relief of those which are in weakness through the medium of the lenses which are prescribed.

(2) Dynamic skiametry *per se* is to be considered as an objective method of determining the negative relative accommodation, when observation and fixation are made at the same point and the lens quantities changed until reversal occurs.

(3) Dynamic skiametric findings taken at the reading point indicate increased convex lens corrections as compared with the static skiascopic and subjective acuity findings when presbyopia, subnormal accommodation or latent hyperopic conditions exist. Such findings indicate the need of lenticular assistance in near work; also, when fusion dissociation tests at thirteen inches (or other point near the eyes) show the existence of an overconvergence associated with the accommodation in cases where little if any refractive errors or muscular imbalances exist at distance.

(4) The dynamic skiametric findings in myopia generally indicate lesser concave lens findings at the reading point than at twenty feet, because the deficiency in convergence, or exophoria, usually associated with myopia, is supplied by the fusional convergence, since the decreased accommodative demands in such cases elicit a corresponding decrease in the convergence associated with accommodation. It is probable, therefore, in cases of myopia in which fixation and obser-

vation points are outside of the patient's far-point, that dynamic skiametry will indicate findings in fair agreement with those which would statically result if the patient's far-point were to be left at the point at which observations are made. If such results accrue, it is evidence that full distance corrections should not be ordinarily prescribed for general use and especially for close work, since a too radical readjustment of the relations between accommodative convergence, fusional convergence and the accommodative act itself is not desirable. The history of the case, the symptoms of which complaint is made, the previous ocular corrections worn, or the absence of any previous refractive attention, must aid the practitioner in the judgment which he forms and prescriptions which he finally gives. In cases where the reserve fusional convergence is extremely weak or heavily overtaxed, it may happen that this deficiency in convergence will be supplied by additional accommodative convergence through an over-stimulation of accommodation, thereby indicating to the dynamic skiametrist as great, or greater, concave lens corrections at near as at distance. The demand for binocular single vision is met by increased accommodative convergence through the medium of accommodation. Or, again, cases may arise in which greater degrees of myopia are indicated at the reading point as compared with the data furnished by the static findings. In such cases there is invariably a pronounced functional exophoria or again a condition of affairs in which this marked divergence is coupled with an accommodative mechanism in which less than one diopter of innervation accomplishes the act of one diopter of accommodative change.

(5) The dynamic skiametric findings, in which hyperopic conditions (i. e., accommodative demands) are apparently found existent at near points, while static methods evidence low-valued myopic conditions at distance demand careful investigation. Such findings are commonly found to exist in connection with spasms of accommodation and in cases in which there is an overstimulation of the interni by virtue of the convergence associated with the innervation delivered in the interests of accommodation, indicating esophoric conditions at the reading point.

(6) All skiametric and subjective findings should and must be supplemented by tests upon the amplitude of accommodation, the reserve convergence and investigations upon the convergence associated with the accommodation, while fusional convergence is passive, at the normal reading and near-work point. Such tests enable the practitioner to correctly analyze his case and to know why and in the interests of what function or functions his final prescription is to be given.

Chapter IV. SUBJECTIVE AND OBJECTIVE METHODS OF DETERMINING THE RANGE AND AMPLITUDE OF ACCOMMODATION BY DYNAMIC SKIAMETRY.

We possess both objective (static skiametric) and subjective methods for the determination of the manifest error of an eye and by means of simple mathematical expressions, taking into account the distance of the lenticular correction from the cornea (i. e., vertex refraction) are able to calculate the manifest or apparent punctum remotum. There are also those determinations upon the absolute refractive conditions which are made through the use of cycloplegics and by which the absolute punctum remotum can be determined. All of these methods have some inherent sources of error which must be avoided by the scientific practitioner. Chief of these sources are: (1) failure to determine the correction of the error of an eye at six meters or more by static skiametric methods due to failure to refract along the usual axis; (2) subjective tests are always invalidated by the factors which affect visual acuity, namely: age, condition of retinal adaptation, size of the pupillary diameter, effects of luminous intensity on the test object and the errors due to difference in the difficulty with which various five-minute letters are read, and (3) the errors accompanying the use of cycloplegics, chiefly those due to the influence of peripheral refraction. In toto, however, it seems scientifically possible to make fairly accurate determinations upon the location of the apparent and of the absolute far-points. We are not as fortunate in some particulars when we come to the determination of the near-point and hence ultimately to the determination of the amplitude of accommodation, which involves the difference between the static and dynamic refractions of the eye. We have been up to within recent years dependent wholly upon subjective tests; at least, in so far as the writer is aware, there were no satisfactory objective methods for finding the range and amplitude of accommodation previous to those methods devised and developed a few years ago and which are to be discussed in this chapter.

As Tscherning says:—"The determination of the near point is not very certain, since its position depends upon an effort of the patient, the strength of which may vary from day to day" (Tscherning's *Physiological Optics*, tr. by Weiland, p. 81); and again, "The determination of the near point is always uncertain because we can never know whether the patient makes a maximum effort or not" (p. 161). And Landolt, writing in his classic *(The Refraction and Accommodation of the Eye,* tr. by Culver, pp. 281-282), says: "If in practice

we seek the punctum proximum we wish to know the maximum refraction that an eye can assume under the impulse of the *will* alone, and not under the influence of a cause foreign to the organism. This will, being manifested especially in the interest of near vision, the person examined should always be permitted to be master of his desire to see distinctly and the judge as to the degree in which he succeeds in so doing. In other words, we are dependent, in the determination of accommodation, upon the patient's good nature and intelligence; a fact which often deprives the examination of the desired accuracy. It is for this reason, too, that there exists no *objective* method (properly so called) of determining the amplitude of accommodation. After having found the static refraction with the ophthalmoscope, it would be necessary to determine, by the same means, that presented by the eye under the influence of its maximum effort of accommodation from which to get the amplitude by subtraction. This effort is hard to obtain from the patient, unless we give him an object of fixation. But, by so doing, we return to the subjective method; the patient will not exert the maximum effort of contraction of his ciliary muscle; in the former case, because it is not necessary; in the latter, because he would still be unable to see the object distinctly, if he were to do his best. * * * In order to know whether or not the object is at the punctum proximum, we must again have recourse to the clearness of the visual impression."

There are two principles or methods of procedure in common use, which are theoretically and in essentials identical, for determining the dynamic refraction. For there is sought by subjective methods (1) *the situation of the near point* and the measurement of its distance from the anterior focus of the eye, the inverse of this quantity representing the total dynamic refraction, or else (2) there is sought and obtained that *lens whose refractive power* equals that of the eye at its maximum of accommodation.

Determination of the Situation of the Near Point and, Thereby, the Accommodation Amplitude, by Means of Dynamic Skiametry.

The common method in vogue is to provide the eye under test—this being a monocular procedure—with that refractive correction which establishes as nearly normal acuity at distance as possible and to then approach the test card carrying No. 2 Jaeger type (V = 0.5D) until the nearest point is reached at which it can still be read or, in other words, until it commences to become indistinct. A measurement of this shortest distance from the anterior focus is commonly taken as the punctum proximum (abbreviated P. P.) or near point. If the distance

ametropic correction is inserted before the patient's eye and this affords normal acuity, the eye is rendered artificially and manifestly emmetropic (in so far as emmetropia can be physiologically approximated during such a series of tests) and the near point determination, if one accepts the validity of this method, gives the true amplitude of accommodation under the conditions of the test and obviates the arithmetical calculations involved in the formula $A = P - R$. In this expression A represents the amplitude of accommodation, P the near point in equivalent diopters and R the far point in equivalent diopters. The distance correction, especially if it includes cylinders, should always be inserted before making these tests. By this we mean to insist upon the insertion of the proper cylindrical corrections in all methods of testing accommodative range and amplitude because of the fact that, by rendering the test objects equally distinct (or indistinct) in all meridians, we provide the subject under test the best opportunity to decipher the letters. Furthermore, this procedure is logical for the reason that astigmatic errors are rarely lenticular, hence the function of accommodation cannot normally have any influence upon the minimizing of such errors. We are all familiar with the marked reductions in visual acuity due to astigmatism, even in low errors; therefore but little more need be said in advocating this procedure.

There are, moreover, certain reasons for the insertion of distance binocular findings (each eye being separately tested), when investigating the accommodative resources at the reading point. These are briefly: (1) the tests upon the total accommodative resources and accommodative reserve are made under conditions imposed upon them by the optical corrections and assistance which the static refractive errors have indicated; the operator is desirous of knowing whether or not such a correction will fit in with the economic and comfortable operation of accommodation and convergence at near points. (2) The accommodative mechanism has been so aided as to permit of its meeting most advantageously the normal demands made upon it as the fixation point is moved from twenty feet to near points. (3) The practitioner is afforded, when the patient is wearing the binocular distance findings, a ready and safe basis for those modifications which he may desire to incorporate in the prescription that he ultimately gives the patient by virtue of the test upon the accommodative amplitude and reserve and upon the muscular poise at the reading distance.

Inaccurate accommodative amplitudes from near point determinations are due, we believe, chiefly to the following factors: (1) there is a more rapid increase of the visual angle under which the test object is seen than of the circles of diffusion, hence the size of the retinal

image increases as the test type is approached to the eye and these diffused but larger retinal images are more easily interpreted mentally than are smaller but sharper images; therefore, the person under test is able to read at a point nearer than that at which accommodation is proportionately enforced: (2) the reduction in the size of the pupil, which normally occurs upon the approach of an object to an eye and which thereby reduces the sizes of the diffusion circles: (3) the effect of closing the lids and thus narrowing the palpebral fissure; this narrowing of the pupillary opening by a narrowing of the palpebral fissure is equivalent in action to a stenopaic slit and is particularly potent and active in high astigmia, and (4) the size of the test-type or line object must bear a certain relation to the visual acuteness of the eye under examination: experimentation by objective methods to be disclosed later in this chapter shows that there are persons who possess a good range of accommodation who cannot read (or *will not* read) fairly fine print at any distance, and, again, there are those who are able to read such print over a wide range whose accommodative amplitude is objectively shown to be relatively depleted.

The reader will, therefore, be appreciative of the fact that the writer has never been enthusiastic about the value of near point determinations as ordinarily made with a tape measure and a few lines of test type. And this, in particular, for the reason that our near test-cards are printed in fonts of printers' type and in nowise observe the scientific standard of a five-minute-angle for the distance specified at which the reading should be done.

Determination of the Accommodative Amplitude by Ascertaining the Lens whose Refractive Power Equals that of the Eye at its Maximum Accommodation, the Test Being Made Monocularly at Twenty Feet.

This test is based upon the fundamental principle that for a person whose punctum proximum is situated at a finite distance, it amounts to the same thing whether he looks at an infinitely distant object through a concave lens or without such a lens at an object situated at a distance equal to the focal length of the lens used. In theory, then, all we need to do is to seek the strongest concave lens (equivalent to the difference between the strongest plus and the strongest minus lenses, or weakest minus and strongest minus lens, dependent upon the ametropia present) "through which an eye still sees distinctly at a long distance and this lens will give the maximum of dynamic refraction of which the eye is susceptible" (Landolt). Hence the strongest concave or weakest convex lens through which an eye can see at a distance gives the refraction of that eye when adapted to its punctum proxi-

mum. The sign of the lens must, however, be changed in our record since concave indicates positive and convex negative refraction respectively. In practice, then, the patient is provided with the minimum concave or maximum convex lens, together with such cylinders as may be demanded, which will afford as nearly V = 20/20 as possible. In this concave-at-distance method the writer usually selects the V = 8/10 line as a basis for the distinct distance vision test.

There are several vital objections to this procedure, however. (1) The visual acuteness is considerably diminished by the use of concave lenses which diminish the size of the retinal images, for it is difficult for experienced observers to judge accurately as to whether their visual acuteness suffers from a lack of clearness or from the diminution in the sizes of the images. (2) The term "distinct vision at distance" is very indefinite. If the normal acuity line is taken as a standard, i. e., when a corrected eye can really develop this acuity, the effect of concave lenses upon the retinal images thereby produced makes it rapidly unreadable. (3) It is difficult to get an eye to put forth its maximum effort of accommodation when looking at a distance. Accommodation is not invited nor encouraged as it is by an object approached progressively to the eye. (4) It is a test upon a function made in a manner which demands that it be brought into play under conditions contrary to those set for it by nature. The minimum accommodative condition of an eye is always demanded and generally obtains when viewing distant objects. It is certainly true that the amplitude of accommodation obtained by this method is less than that furnished (apparently) by a direct determination of the near point in the manner discussed in previous paragraphs. The reasons are very obvious, for the factors, such as increase in size of retinal images, which are likely to cause a pseudo near point which is too close to the eye, are exactly reversed in their nature, i. e., a decrease in the size of retinal images when using concave lenses and viewing a distant test-object. It seems not at all improbable that an average of the two amplitudes obtained by these two methods will give, in the general run of cases, a fairly true estimate of the real amplitude of accommodation. Very radical differences do, however, arise in the results of the two methods and these differences should form most available diagnostic data.

Determination of the Amplitude of Accommodation by Ascertaining the Lens whose Refractive Power Equals that of the Eye at its Maximum Accommodation, the Tests Being Made at Thirteen Inches.

We shall refer to this method as the *concave-at-near* procedure. The normal reading point is ordinarily about twelve to fifteen inches from

the eyes; we shall take thirteen inches, equivalent dioptrically to 3 D., as a normal reading distance. A moment's consideration will convince the reader that a very logical procedure in investigating the amplitude of accommodation would be to find its reserve at the reading point and to then add this quantity to the three diopters demanded while reading No. 2 Jaeger at thirteen inches. It should be accepted as a fundamental principle that *any ocular function should be investigated under conditions of activity or quiescence which conform to the philosophy of the particular phase of its activity under consideration.* The normal reading point is at a foot from the eyes; it is logical, therefore, to determine its reserve with respect to the point at which this reserve should hold. The thirteen inch or thirty-three centimeter point should be ordinarily chosen as the point at which the accommodative resources are to be investigated rather than a nearer or more remote point, for the reason that nature has ordained the establishment of a comfortable convergence point (leaving two-thirds to three-fourths of the fusional convergence in reserve) and a normal distance of distinct vision at about a foot from the eyes. In passing, let it be stated that we believe that the function of convergence, which normally remains constant in its strength, rather than accommodation, which becomes depleted with age, is the determining factor in the establishment of this normal reading or close work distance.

The method is easily carried out. The test should be made monocularly and before each eye should be placed the distance correction, particularly the cylindrical element. The spherical element should be the maximum convex or minimum concave lens which, either alone or in combination with the cylinder, as the case may be, affords $V = 20/20$, or as nearly the normal standard as can be obtained. The writer ordinarily uses No. 2 Jaeger type ($V = 0.50$ D.) held at thirteen inches; the ciliary must then exert three diopters of accommodative action or, at least, produce three diopters of lenticular action or refractive change if normally acting. Minus spheres, beginning in general with a —1 or —1.5 diopter glass, are then inserted in the trial frame or turned up in the lens battery in connection with the phoro-optometer until the maximum minus lens has been inserted through which the No. 2 Jaeger is just barely readable. The available amplitude of accommodation as thus obtained is the sum of the three diopters exerted by the accommodative mechanism in order to read at thirteen inches plus the amount of concave lens power overcome and expressed as a positive quantity.

Since the effect of concave lenses is to minimize the sizes of retinal

images and hence the apparent sizes of the test-objects, it should be expected that the amplitudes of accommodation as determined by concave-at-near methods would be less than by near-point determination.

We append a table of amplitudes of accommodation as determined by various investigators.

TABLE SHOWING AMPLITUDE OF ACCOMMODATION.

Age	Donders (near point)	Duane (near point) Average	Jackson. (Concave Lenses. Accommodation Associated with Convergence)	Sheard- (Monocular Test. Object at 13 in. Concave Lenses)
10	14.	13.5	14.	....
15	12.	12.5	12.	11.0
20	10.	11.5	10.	9.0
25	8.5	10.5	9.	7.5
30	7.0	8.9	8.	6.5
35	5.5	7.3	7.0	5.0
40	4.5	5.9	5.5	3.75
45	3.5	3.7	4.	....
50	2.5	2.0	2.5	....
55	1.75	1.3	1.25	....
60	1.00	1.0	0.5	....

In closing this presentation of subjective methods of investigating the range and amplitude of accommodation the following case is cited as illustrative of the variations possible in the findings and conclusions which might possibly be drawn.

Case 1. Young girl 8 years of age. Subjectively, O. U. + 0.50 ⊃ + 0.50 ax. 90 gave V = 20/20 with difficulty. O. U. + 1.00 ⊃ + 0.50 ax. 90 blurred distance vision to V = 6/10. Through — 0.50 ⊃ + 0.50 ax. 90 or through only — 0.50 D. S. she could hardly distinguish the 50 foot letters at 30 feet or even distinguish relatively small objects in the room. Her total monocular accommodative amplitude as made by tests at distance amounted to about 1.5 diopter. She could not read No. 2 Jaeger type (wearing her distance corrections) at 13 inches but could read it when this type was pulled up to within four or five inches of her eye. This is a condition, as we interpret it, of pseudo near-point, associated with a spasm of accommodation or subnormal conditions therefore. It is doubted—from these tests unless corroborated by objective tests—whether or not she was possessed of any more refractive change through accommodative effort at 5 inches than she

was at 13 inches, because the decrease of size of the pupil, the narrowing of the palpebral fissure and the increased sizes of the retinal images might enable her to read at the closer point and not at the usual reading distance. Hence the great need for objective methods of determining the accommodative amplitude.

An Objective Method of Determining the Monocular Amplitude and Range of Accommodation, by Dynamic Means.

All subjective tests should be supplementary to investigations by objective methods. Whenever possible objective methods should be devised and used even though they may fail to agree in toto with various subjective tests and even though they may have their probable or apparent inherent source of error.

Static skiametry is a striking example; many practitioners reject the method because it does not agree with the subjective findings. The very differences are, however, of great value provided such methods are practised intelligently and with confidence. And in passing, static skiametry is probably more nearly scientifically accurate in its findings, especially when practised by the person of trained mind and skilled eye and carried out under auspicious conditions, than is the subjective method. And this is in the face of the fact that it may seem nonsense to say that the operator can tell what an eye needs better than that eye itself can tell. Yes, indeed, what an eye *ought* to have may be told with considerable accuracy; what it may *accept* from the acuity standpoint is another matter.

In 1917 the writer published in a little volume on *Dynamic Ocular Tests* a description of an objective method of determining amplitudes of accommodation. At that time he modestly claimed the first recorded account of such tests. Since that time, however, he has come across certain paragraphs in Jackson's *Skiascopy* (pages 84-85) which lead him to believe that the two methods are, fundamentally at least, the same. And possibly somebody antedated both of us! At any rate it is a pleasure to emphasize in the following pages the simplicity of the method and the value of the data thus obtained. The description of the monocular objective test will be supplemented by its applications to binocular investigations upon the accommodation.

Figures 5, 6, and 7 show diagramatically the general modus operandi in the monocular method. Each eye should be, in turn, occluded and its accommodative range investigated, since some of the most interesting and important cases from the ocular economic standpoint are those involving marked differences between the accommodative resources of the two eyes.

In practice matters are so arranged that the object viewed (Figure 5) shall be reasonably illuminated. The flooding of the room with artificial light, especially if this be by indirect or semi-indirect methods of lighting, is not objectionable except from the operator's standpoint.

Fig. 5.—Fixation Test-object for Use in Obtaining the Objective Values of the Monocular and Binocular Accommodative Amplitudes.

With experience, however, one can use retinoscopic methods and follow the reflexes with ease and accuracy under almost any subdued luminous surroundings. The writer invariably uses the self-luminous instrument in these tests.

The patient is given a line of type printed in about 10 or 12 point type upon a card about one-quarter inch wide and fastened to some

convenient holder such as illustrated in Figure 5. Or a single line ruled on a card or a pencil will serve satisfactorily as a fixation object, but there is not the incentive to full accommodation as when reading is demanded. The full monocular distance finding, affording as nearly V = 20/20 as possible, is inserted before the eye to be tested. The patient is then given the test object—which he holds initially at about 13 inches—and told to read the letters. Or the operator may hold the test object in one hand and approach it toward the patient. In general we have the patient hold the card slightly to the nasal side during the examination of either eye while we proceed to examine skiametrically from the temporal side and as close to the visual line as possible.

In Figure 6 there is represented the optical and ocular conditions present when the retina and the object viewed are conjugate points and the exact or requisite number of diopters of accommodation de-

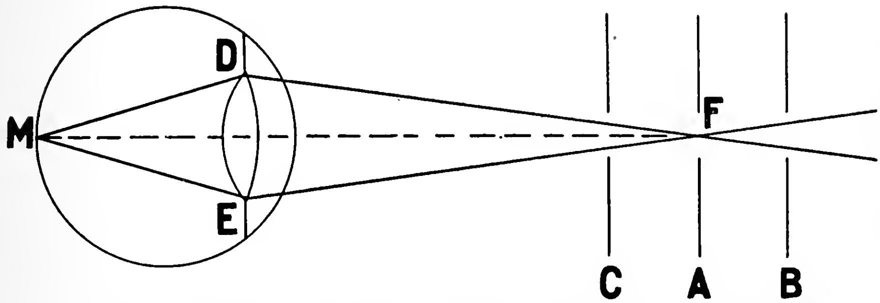


Fig. 6.—Illustrating the Optical Principles Involved in the Objective Monocular Test upon Accommodative Amplitudes. (Sheard.)

manded for the point fixed are supplied. Under these conditions, therefore, with the accommodative point kept constant at F and the mirror A in the same plane a neutral shadow condition should obtain and by moving the retinoscope to C—an inch nearer the eye—a hyperopic condition should be revealed or by withdrawing an inch farther from the eye, as at B, a myopic condition should be evidenced. By then moving or having the patient move the test-object nearer the eye the actual near-point will be found as soon as the retinoscopic mirror has to be operated in a plane back of the fixation point in order to obtain a neutral shadow. These are ideal conditions in that we are assuming the presence of a true or artificially produced emmetropia and a perfectly innervated and functioning ciliary and lenticular action, and that there is no lag of accommodation behind convergence as discussed elsewhere. In short, we are here writing of *ideal* and *physically* perfect conditions.

In general, however, it is found that when the patient, wearing the full distance correction, reads monocularly the letters (which, by the bye, may be as small as the patient can see), there is a "with" or hyperopic motion—using the plane mirror—indicating that the point conjugate to the retina in an eye optically statically perfect is not at the position of the object viewed but at a point somewhat behind that point, i. e., farther from the eye. Three valuable tests may be made. *First:* with monocular fixation and observation skiametrically at any point desired the operator can find that convex lens power which must be added in order that the monocular accommodative demands, in the interest of conjugacy of retina and object viewed, may be met. This would be shown by the additional lens power needed to give a neutral retinoscopic reflex. Suppose that 1 D. is thus demanded when both fixation and observation points are at thirteen inches: our interpreta-

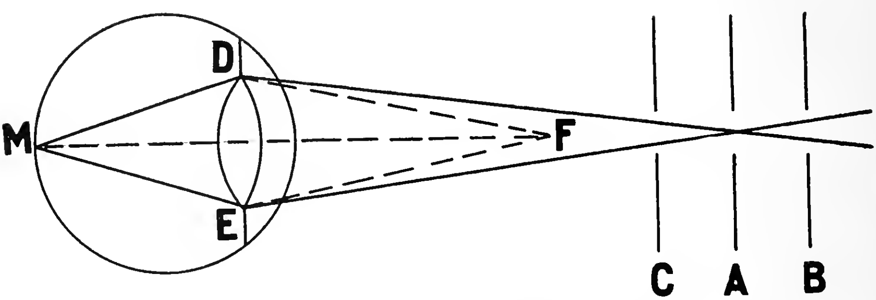


Fig. 7. A. Illustrating the Procedure in Obtaining Skiametric Determinations of the Accommodative Amplitude. (Sheard.)

tion would be that objectively an assistance to the accommodation over and above the assistance (or burden and tax in cases of overcorrected myopia) afforded by the static finding given the eye, is required to relieve the accommodation of an extra burden. Notice that we specify minimum amount of additional lens power to produce neutralization skiascopically; more assistance might be and generally would be accepted under the method of procedure we have disclosed. *Second:* observation may be kept constant at any distance specified and the test-object drawn closer to the eye until a neutral shadow is obtained. In Figure 7, let F be the point viewed and A the position of the operator's mirror. If a certain test shows that *D F* is 10 inches (4 D) and *D A* is 13 inches (3 D) we should conclude that the accommodation actually available at ten inches is sufficient only for optical conjugacy at 13 inches, hence indicating the need of a diopter of lenticular assistance. We must, however, bear in mind the probable physiological

lag of accommodation which amounts, in the average case, to about one-half diopter. *Third:* by approaching the object closer and closer to the eye a point will finally be found such that no nearer approach of the test-object to the eye changes the neutral condition of reflex as skiascopically observed at the closest point to the eye at which a neutral shadow is obtained.

In testing, therefore, for the near-point objectively we proceed as follows: The patient draws the test-object as near the eye as will still permit of its reading. To the observer at thirteen inches the skiascopic reflex will show an "against" or myopic condition indicating that he

Fig. 7. B. Illustrating the Procedure in Obtaining Skiametric Determinations of the Accommodative Amplitude. (Sheard.)

is outside of the optical ocular far-point *dynamically* considered. The operator then moves forward until he obtains the neutral shadow position. The test-object is then to be carried still closer to the eye (blurred image makes no difference) and the nearest point of neutral shadow found and measured. This gives the apparent near point under whatever ocular conditions the test is made (ordinarily when wearing the distance correction) and from it the range and amplitude of accommodation are easily determined. We measure the distance *D A* (Figure 7) and not *F D*. We occasionally vary this test and, with observation and fixation at thirteen inches, produce neutralization of shadow at this point and then proceed as outlined above. We are, however, partial to the test in which the static finding is worn.

The method is certainly very simple and quickly carried out. The question arises: Are there any inherent errors? Yes; those of observation and of optical imperfections, lack of response on the part of the person under test, and the difficulties of making accurate measurements of distances. For this latter purpose we use a light-weight, narrow tape-measure, one end fastened to the trial frame with due allowance for distance from the cornea, and the other end weighted, the tape when in use being carried between the finger and thumb of the hand holding the retinoscope.

These tests must certainly suggest themselves to the reader as being most valuable, especially in finding the range and amplitude of accommodation in children (for one can employ small colored pictures pasted on the rear side of the test-object shown in Figure 5); in presbyopia; in subnormal accommodation; in excessive accommodation; in amblyopia, when we are uncertain whether or not accommodation is still active because of the uncertainty of subjective tests by virtue of the reduced visual acuity, and in anisometropia.

Likewise we are provided with an objective method which tells us whether or not accommodation is proportionately enforced in those rather frequent cases, already alluded to, in which the patient, usually young in years, is not able to read fine print at fourteen inches but can read it when brought up very close to the eye. Our answer is that these tests demonstrate the universality of lack of proportionate accommodative action and that such type is read at points abnormally close to the eye because of increased sizes of retinal images, constriction of pupil and narrowing of the palpebral fissure.

Furthermore, these objective tests show that the amplitudes of accommodation are in closer agreement with the results tabulated in a preceding section under the concave-at near method than they are with monocular near points and binocular concave-at-distance methods.

An Objective Method of Determining the Binocular Range and Amplitude of Accommodation and the Effects which Convergence Excesses and Deficiencies Have upon the Same.

We are closing this chapter with the application of the principle of the monocular objective method of determining the range and amplitude of accommodation to binocular investigations upon the functions of accommodation in each eye as correlated with that of convergence. The one very vital factor which enters into these binocular tests and which is, presumably, absent from monocular investigations when the eye not under examination is occluded, is that of *convergence,* as it is commonly expressed. For this term *convergence* we ought properly

to write *binocular single vision.* There is, ostensibly, less likelihood of a true analysis of ocular conditions being made and less likelihood of an ability to interpret the data obtained when two functions, not wholly independent neither wholly dependent one upon the other, are investigated under conditions in which they are coördinated in a manner such as will give binocular single vision (convergence) and distinctness of vision (accommodation), than there is when each function is investigated, in so far as possible, by itself.

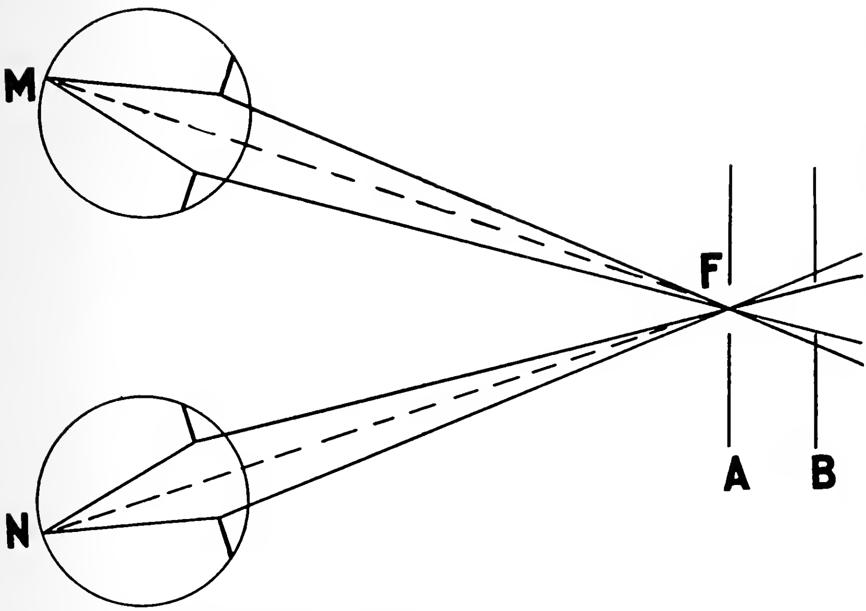


Fig. 8.—Illustrating the Optical Principles Involved in the Binocular Accommodative Amplitude Tests. (Sheard.)

But the binocular methods to be described are most valuable in many cases and as a well-known American ophthalmologist and an authority on ocular muscles said to the writer: "We are still guessing these optical puzzles"; hence that which is of value even in a small percentage of cases is worthy of preservation and use. Marked departures in the values of the objectively obtained binocular and monocular near-points are nearly always indicative of disturbances in the extrinsic muscles or their innervations or the supplementary convergence. Excessively close binocular near-points as compared with the monocular tests usually accompany conditions of over-convergence or genuine excessive accommodation, while in those circumstances in which the binocular accommodative near-point is farther from the eyes than is

the monocular objectively determined punctum proximum, weakness of convergence or abnormal divergence is present.

In determining the binocular range of accommodation we use a test-object such as that shown in Figure 5. The subject approaches this toward his eyes while the practitioner follows behind with his retinoscope until he has determined the closest position at which he can obtain a neutral shadow even though the test object may be approached still nearer the eye. There is diagrammed in Figure 8 the ideal conditions of convergence and accommodation and the determination of the binocular near-point, and there is shown in Figure 9 the ordinarily found arrangement of fixation and position of the observer when the closest neutral shadow position is obtained. For if, as in Figure 8, we have a pair of eyes in which the monocular accommodations are so perfectly regulated that one diopter of innervation produces one diopter of actual accommodative or refractive change, and if the accommodation as associated with convergence is so perfectly adjusted that, in conjunction with the supplementary or fusional convergence, the commonly accepted standard relation of three to one (this ratio being dependent upon the value of the meter-angle) between convergence and accommodation obtains so that the convergence and accommodative fixation points are one and the same, then the fixation point F and the observation point A will remain one and the same until the binocular near point is reached. A further approach to the eyes will, however, give a "with" motion (when the plane mirror is used) since the accommodation can no longer keep up with the convergence, i. e., an object would be seen single but indistinctly or double but distinctly, and the binocular *dynamic* far-point (or subjective near-point) would be back of the fixation point.

In the majority of cases we find the conditions as shown in Figure 9, in which the fixation point B is nearer the eye than the neutralization of the retinoscopic shadow position at O when the same has been determined at its closest position to the eyes. That the binocular near-point is ordinarily, either by subjective or objective methods, nearer the eyes than is the monocular near point argues for a greater activity on the part of accommodation when associated with convergence than when not so associated and especially under the impetus of overconvergence when the convergence punctum proximum and binocular accommodative near-point approximate each other. This is, however, one of the intricate ocular problems and, in so far as we are aware, it is rather commonly accepted that "whatever may be true of other associated brain-centers, it appears that the center of the ciliary muscles and the third conjugate innervation center (the one to converge

both eyes) can have the associated impulse to run in only one direction; that is, from the former to the latter." (Savage.) Such a statement is probably correct when we have reference to the convergence as associated with the accommodation but it does not necessarily follow that the third member which enters into binocular single vision, namely the fusion convergence, may not alter the convergence associated with certain accommodative conditions and thereby make avail-

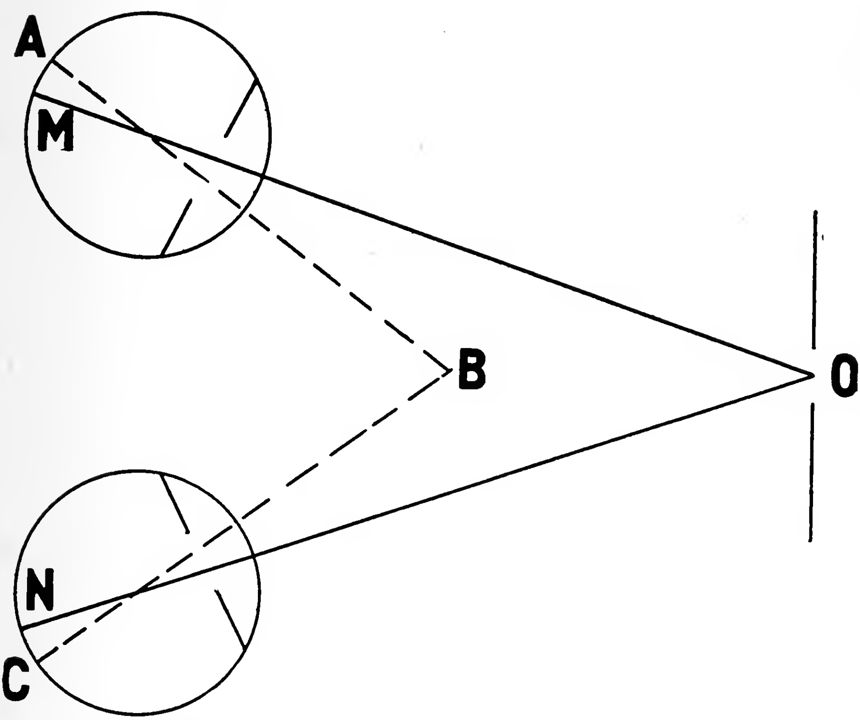


Fig. 9.—Illustrating the Procedure in Obtaining Skiametric Determinations of the Binocular Accommodative Amplitude. (Sheard.)

able greater accommodative possibilities. In fact, the proof is conclusive that the fusion convergence serves as the correlating medium between the accommodation and convergence associated with it in order that fixation may be one and the same, both from the accommodative and convergence standpoint, when possible.

We may well ask with Howe: "Of what clinical importance is the difference between the binocular and monocular near-point?" To the writer's notion the answer lies in the process of convergence or as the result of the act of convergence. For if the type is tested as to its

accommodative resources in its straight-away, parallel-axis position (as when looking at twenty feet) no convergence is involved, hence we should expect to experimentally obtain the minimum value of the accommodative resources when this function is investigated at 20 feet. When the tests are made monocularly, either by objective or subjective methods, only that convergence which is associated with the act of accommodation is in operation. This accommodative convergence we believe to be, under *standard conditions*, less than the amount demanded for binocular single vision at any given near point. Hence this must be supplemented by fusion convergence. We likewise have reason to believe that the portion of the convergence demands met by the accommodation increases as the fixation point is approached toward the eyes, since the fusion convergence increases at points closer to the eyes as shown by such investigations as those recorded by Maddox *(The Clinical Use of Prisms,* page 98). The accommodative and convergence functions are, in part, independent of each other and, in part, interdependent; we should, therefore, expect the monocular accommodative tests to indicate greater values of the accommodation when associated with accommodative convergence than when tested at points involving no such convergence and less, in turn, than the results shown by tests upon the binocular accommodative resources. There must, therefore, be an interplay of accommodative and fusional convergences whereby the convergence makes possible a slightly greater dynamic refractive change under a given delivery of innervation to the accommodative mechanism. Under excessive positive convergence tendencies or in which the positive fusion convergence is extraordinarily large we should expect a greater binocular than monocular range of accommodation. A binocular amplitude of accommodation which is in excess of the monocular amplitude by a diopter or more is, in general, indicative of an associated positive overconvergence or a subnormal accommodation. When the reverse conditions exist, the binocular accommodative near point is farther from the eye than is the monocular, we may conclude that there is a deficiency in either the accommodative convergence or the positive fusion convergence, or both. In the clinical use of the binocular test we supply the eyes with the full distance binocular findings (the same, however, as used in the monocular method) and determine the nearest point at which the shadow stays neutral. For, if we are outside of the accommodative far-point, the shadow or reflex will move "against" the mirror motion (using the plane mirror) and if inside, it will move "with." There is evidently one position of the observer's mirror in which, with a constant approach of the test to the eyes, it will be at the closest point possible for a neutral shadow.

It may be claimed that this method is similar to, or the same as, that known by the name of "dynamic skiametry." It is, in part, a modification of this system and when the dynamic skiametric tests, with fixation and observation at the customary reading distances, are being carried out, these monocular and binocular range of accommodation tests can be readily made. But the nature and purposes of these tests are entirely different from those involved in dynamic skiametry. In the former we are testing for the maximum available amplitude of accommodation, while in the latter it is presumed that there will be objectively indicated, when neutral shadows are obtained, that lenticular assistance at any fixation point such that accommodation and convergence will be harmoniously correlated at the point of test or at least give a measure of the accommodative assistance actually needed at the point of test.

A few illustrative cases must suffice to emphasize the importance of these discussions upon subjective and objective monocular and binocular tests upon the amplitudes of accommodation. It is suggested that these illustrative examples be again read after the discussions on convergence which follow in the succeeding chapter.

Case 1. *Normal monocular and binocular accommodative amplitudes.* Miss E. N. Aged 25 years. *Static skiametry.* O. U. + 1 D. S. *Dynamic skiametry,* fixation and observation at 13 inches, O. U. + 1.50 D. S. in order to obtain neutral shadows. *Subjective* tests, O. U. + 1.25 D. S., V = 20/20 binocularly and equally good in each eye although not quite 20/20 monocularly. *Monocular near-point,* reading No. 2 Jaeger (V = 0.50 D.) through distance correction, showed the punctum proximum to be at 5 inches: the binocular test gave 4 inches or 10 diopters of accommodation. *Concave-at-near tests* at 13 inches demonstrated a monocular amplitude of 8 diopters of accommodation, i. e., the No. 2 Jaeger was just readable through a —5 D. lens and this, in addition to the three diopters of accommodation presumably developed at the thirteen inch test-point, indicated eight diopters of accommodation. The *objective monocular accommodative test* gave, for each eye, 7 D., the binocular test indicated 8 D. In all these tests the subjectively determined corrections were worn.

Case 2. *Presbyopia.* The *subjective* findings, in excellent agreement with the *static skiascopic* findings, gave in the case of a woman, 58 years of age, standard acuity under O. D. + 1.75 D. S. ⌒ — 1.25 ax. 180, and O. S. + 2.00 D. S. ⌒ — 1.00 ax. 180. *Dynamic skiametric* determinations at 16 inches (the point at which she desired

to read and work) gave O. U. + 4.00 $\bigcirc$ — 1.25 ax. 180: the *objective accommodative* tests, the person under test wearing the statically determined corrections, demonstrated a monocular near point of 20 inches or the equivalent of 2 diopters, while the binocular objective test showed 16 inches, equivalent to 2.5 diopters, before reversal skiametrically occurred. Therefore, for reading purposes at 16 inches (equivalent to 2.5 D.), allowing her to retain one-half her available amplitude of accommodation in reserve, (the accommodative amplitude in this case being practically two diopters) she was given an additional + 1.75 O. U. for reading purposes.

By way of comment we desire to remark upon the fact that there are as many, if not more, blunders made in fitting presbyopia scientifically than in any ocular derangements or abnormalities, simply because practitioners do not determine the amplitude of accommodation. It is of importance that the accommodative resources be not taxed, on the one hand, nor too much relieved on the other, for one condition produces discomfort and the other leads to weakness and decrepitude of the function through lack of normal use. Objective monocular and binocular accommodative tests and the findings by dynamic skiametry are the most scientific methods we possess. As a passing fling at the "visual acuitists" we say that the fact of the production of normal "seeing" is but a small portion of the real work of the modern refractionist. In the particular case just cited, for example, we find the following data recorded: 1 $\triangle$ exophoria at distance: at the reading point, under fusion dissociation tests, a need of 20 $\triangle$ base in to align the images, thereby showing a total or complete lack of convergence as associated with the act of accommodation. In addition, there was a positive fusion reserve of 10 $\triangle$. This woman needed and received a prismatic correction in the reading glasses (1.5 $\triangle$, base in, over each eye was given) in order to enable the act of binocular single vision to be made with greater comfort. But more of this, with explanations, in the next chapter.

Case 3. *Unequal monocular amplitude of accommodation.* E. P. B., aged 21 years; headaches; dryness of the eyes; cannot read for any length of time; extremely sensitive to light. *Distance correction,* acuity equally good and 20/20, O. D. + 0.50 D. S. $\bigcirc$ — 0.37 ax. 180 and O. S. + 0.87 D. S. $\bigcirc$ — 0.50 ax. 180. *Monocular objective accommodative* tests, the distance corrections being worn, gave O. D. 5 inches, or 8 D., and O. S. 4 inches or 10 D. *Concave-at-near* methods demonstrated the *accommodative amplitude* to be O. D. 8 D. and O. S. 10 D. Retests on different occasions corroborated these findings.

Hence the tests show clearly that the amplitude of accommodation of the right eye is less than that of the left. A spasm of accommodation was rightfully suspected, the cause lying in the disclosures made through other tests that the convergence reserves were weak and overtaxed, thereby demanding over-accommodation to enable binocular single vision to be maintained for any period of time.

Case 4. *Amblyopia.* In the particular case of a man, aged 30, the *static skiascopic* findings were: O. D. + 3.00 D. S., O. S. + 5.00 D. S. *Dynamic skiametry* showed O. D. + 3.50 D. S., O. S. + 6.50 D. S. *Static subjective* tests gave O. D. + 2.50, V = 20/20 and O. S. + 4.00, V improved from the counting of fingers to about 2/10; this could not be improved upon. The monocular *objective accommodative test* showed that the right eye had 4 D. of accommodation but that the near point accommodatively for the left eye was 20 inches or 2 D. Some 8 △ of esophoria were elicited at distance. No satisfactory tests could be made upon the convergence-accommodation relations at close points. The data do show, however, the possibility of producing marked improvement in the vision of the left eye for the following reasons: (1) The correction of the hyperopic error produced an appreciable improvement in visual acuity and (2) there was evidence of accommodative innervation and lenticular change under this innervation. To briefly describe the history of this case we may say that, initially, the visual acuity of the left eye was improved by occlusion methods: the two eyes were then trained to work together in the act of binocular single vision and rather rapid facility was acquired in this matter.

Case 5. *Anisometropia with good range of accommodation.* Young girl, aged 10 years. *Static skiascopic* findings showed O. D. + 3.00 D. S. ⌒ − 5.00 ax. 10, O. S. + 0.37 D. S. ⌒ + 0.50 ax. 90. *Subjectively,* O. D. + 2.50 ⌒ − 4.75 ax. 100 gave V = 8/10 while the static finding for the left eye gave V = 20/20. The monocular *objective accommodation,* wearing the above correction, showed O. D 5 diopters and O. S. 8 diopters. Distance *muscle tests* evidenced 4 △ exophoria and tests at 13 inches demonstrated 10 △ to 12 △, base in, to align the dots, indicating that the *accommodative convergence* amounted to 10 △, (i. e. 18 △ + 4△ − 12 △). The *near points* were O. D. 9 inches and O. S. 4 inches. The maximum *positive reserve convergence* at 13 inches was 10 △. The patient was given the *subjective* findings for constant wear with advice to use the "finger" or "pencil" method (i. e., a drawing of the finger or a pencil toward

the nose until diplopia ensues) for developing additional convergence reserve and to cover the left eye for short periods of time several periods a day and to exercise the right eye by reading coarse print. This was done with the result that after six months the accommodation in the right eye had developed an additional diopter and a half and the reserve convergence had been increased about 5 $\triangle$.

Case 6. *Anisometropia. One eye hyperopic, the other myopic.* This interesting case is rehearsed because it shows that, without correcting lenses, one eye only engaged in the act of vision at close points, hence barring binocular single vision; while after being corrected and wearing these lenses both eyes developed practically equal amplitudes of accommodation.

L. S. Aged 18 years. Some frontal headaches, particularly over the right eye. Eyes strain and fatigue easily. No blurring of type. No diplopia at distance or close points. *Static skiascopic* measurements showed: O. D. + 0.75 $\bigcirc$ + 1.00 ax. 75 and O. S. — 2.50 $\bigcirc$ + 0.37 ax. 180. *Dynamic skiametry* evidenced the findings at 13 inches as: O. D. + 1.50 $\bigcirc$ + 1.00 ax. 75 and O. S. — 1.25 $\bigcirc$ + 0.37 ax. 180. Without corrections, the *monocular objective amplitudes* of accommodation were O. D. 9 D. and O. S. 10 D., due allowance being made for the static findings. *Binocularly,* however, the amplitudes of accommodation were: O. D. 1 D. and O. S. 10 D., indicating clearly that, in close vision, the right eye did not function accommodatively and that vision in that eye was thereby inhibited. *Subjective tests* gave O. D. + 0.50 $\bigcirc$ + 1.00 ax. 75 and O. S. — 2.50 $\bigcirc$ + 0.37 ax. 180 with V = 20/20. Visual acuities without correction were O. D. 20/30 and O. S. less than 20/100. With the subjective findings, the binocular amplitude of accommodation was found to be practically 10 D., each eye developing equal accommodation. Furthermore, when the refractive corrections for the anisometropia were omitted, the interesting phenomenon of changing of the "seeing" or fixing eye could be observed objectively, for as the fixation object was slowly drawn from the face and passed beyond the punctum remotum of the myopic eye, the visual act was taken up by the hyperopic eye. Likewise, the reverse process could be watched. Such tests as these throw interesting light upon the manner in which two such refractively different eyes work.

Case 7. *Binocular amplitude of accommodation greater than the monocular.* This case illustrates the importance of tests upon the amplitude of accommodation, the rather decided difference between

static and dynamic skiametric findings and the noticeable variation between the monocular and binocular objectively determined amplitudes of accommodation.

Miss E. K. 12 years of age. Complained of frontal headaches and inability to read in the late afternoons and evenings. *Static skiascopic* tests evidenced O. U. + 1. 25 D. S. *Dynamic skiametry,* the patient wearing the distance corrections, fixation and observation being made at 13 inches, disclosed a decided "with" motion requiring O. U. + 3.00 D. S. in toto in order to neutralize the motion. Binocularly, under subjective tests, O. U. + 1.00 D. S. were accepted giving V = 8/10 to 10/10. The *accommodative convergence* showed 4 △ of over convergence: the *tonicity* tests at 20 feet evidenced 4 △ esophoria, the patient wearing the static findings. The *objective monocular accommodative amplitude* test gave 3.5 D.; the binocular tests showed 5.5 diopters. The *subjective accommodative* tests disclosed the fact that the patient could not monocularly read No. 2 Jaeger at thirteen inches and that the same was read binocularly with great difficulty. With a reading correction of O. U. + 2.00 D. S. this type could be read but not closer than 10 inches. The case was referred to a neurologist and after examination was returned for a correction for general wear, all close work being prohibited. O. U. + 1.25 were prescribed. Finally, however, bifocals were given and these proved eminently satisfactory for some time, when finally a single pair of glasses was found ample after the systemic derangements had been overcome.

Case 8. *Binocular amplitude of accommodation as objectively determined less than the monocular.* Mr. J. W. Aged 25 years. Suffered a nervous breakdown some years ago and is still under a physician's care. On the initial visit he stated that his eyes troubled him a great deal although he had worn glasses for several years. *Static skiascopic* findings showed O. U. + 0.62 D. S. ⌢ + 1.12 ax. 90 and O. S. + 0.62 D. S. ⌢ + 1.50 ax. 90. *Dynamic skiametry* disclosed practically the same findings: if anything a trifle *less* spherical power. *Subjectively* it was found that the static skiametric findings afforded satisfactory vision. The *monocular objective accommodative test,* wearing the distance corrections, showed near points of 8 inches: the *binocular* test disclosed a near point of 12 inches, or 3.3 diopters, of accommodation as the maximum that could be used (not developed, however) in binocular single vision. The reasons why these conditions existed are evident from the following statements: (1) a tonic exophoria of 6 △, (2) the entire absence of any accommodative convergence, since 20 △ base in. was required at the reading point to bring the test-objects in alignment and (3) a positive fusional con-

vergence reserve of about 8 △. After testing this case on several occasions over a period of years we have to report that the adduction (as ordinarily interpreted from prism measurements) is nil at 20 feet, i. e., there is a paresis of convergence. He is, however, able to develop about 6 △ to 8 △ of positive fusion reserve at the usual reading point and since he sees binocularly and single at distance he possesses enough positive fusion at this distance to overcome his exophoria. Lately, however, the exophoria at distance has increased and prisms have been incorporated in both distance and reading corrections. As will be seen from the above data, the amplitudes of accommodation are low, considering the age of the patient. The monocular near points do not exceed 7 inches, nor is he able to read Jaeger No. 2 through more than about a — 3 D. lens at thirteen inches.

Chapter V. Tonic, accommodative and fusion convergences and their importance in refractive work.

Physiologic Exophoria.

Experimentation by von Graefe, Maddox, Howe, Worth, Theobald, Eberhardt, the writer and others has demonstrated that, in the average case, "if one eye be covered while the other is fixing a near object, the occluded eye will, in the majority of persons who are neither hypermetropic nor presbyopic, deviate outwards about three to four degrees." These researches demonstrate, therefore, that under normal conditions binocular single vision is not obtainable at points close to the eyes solely through the medium of the convergence as associated with the act of accommodation. This deficit or difference between the actual convergence demanded for binocular single vision at any near point—let us specify the ordinary thirteen-inch reading distance as that point—and the convergence as supplied through the innervational channels associated with the accommodation, is known as *physiologic exophoria.* In order that binocular single vision may ensue it is necessary that this deficiency be overcome by a visual reflex action, or *fusion reflex.*

Normally, therefore, we should not expect binocular single vision to be obtained except through the supply of some three or four degrees of fusion convergence from a source or center wholly independent of the accommodation. Maddox, by means of his tangent scale (in America known, in a modified form, as Stevenson's muscle test)—carrying an arrow at the center of a scale graduated to both the right and left thereof and made visually double by the use of prisms base up and down before each eye respectively, the tests being made at

25 centimeters—concluded that there was a physiologic exophoria at the 10 inch point of about 3 △ to 5 △ measurable and corrigible (i. e., to place the arrows vertically one above the other) by the use of prisms base in. A modified form of this device for near-testing is shown in Figure 14 and will be briefly discussed in connection therewith. This physiologic exophoria, which should be normally revealed at points close to the eyes when fusional convergence is made passive through the use of prisms base up and down respectively before each eye, shows that the convergence is not complete centrally and that the additional convergence supply must come through the medium of fusion convergence, a function entirely separate from the convergence as associated with the accommodation.

The writer of this essay has completed a fairly exhaustive investigation upon the subject of physiologic exophoria at close points. The point chosen in the results tabulated in the next paragraph was the thirteen-inch reading point. During the course of a year's experimentation about three hundred subjects were found who satisfied the following requirements: (1) The visual acuity, under the static corrections determined upon, was not less than 20/24 in each eye; (2) no vertical imbalances in excess of ½ △ were admitted; (3) no esophoria or exophoria at twenty feet in excess of 2 △ as a maximum, the patient wearing the static findings which afforded the maximum binocular correction without reducing the visual acuity; (4) no anisometropia greater than one-half diopter difference; (5) absence of pathologic conditions, and (6) no accommodative spasms or other indications of a pair of eyes in an irritable or erratic condition.

The subjoined table gives the summarized results of the 315 selected cases. Column I furnishes the number of prism dioptries, base in, (hence the measure of the *lack* of central fusion through the accommodative convergence) required by the method of testing to be described under the sub-topic Accommodative Convergence; Column II, the number of persons exhibiting the amount specified; Column III shows a "grouped" arrangement as judged to be fair and proper by the writer and Column IV gives the percentages of the various groups possessing the amount of exophoria at thirteen inches specified in Column I.

TABLE ON PHYSIOLOGIC EXOPHORIA (315 CASES) AT 13 INCHES.

I. △ (prism dioptries) of Exophoria at 13 Inches.	II. Number of Persons.	III. Grouped Totals.	IV. Percentage (approx.).
0	34	41	13
1	7		
2	29	65	22
3	36		
4	40	81	26
5	41		
6	21	61	22
7	4		
8	36		
9	1	31	11
10	28		
11	2		
12	13	26	8.4
13	2		
14	3		
15	8		
18	4	10	3.3
..	..		
20	6		

These results indicate that 70 per cent. of the persons examined possessed an exophoria of from 2 △ to 8 △ at thirteen inches and that the maximum percentage, namely 26 per cent., showed an exophoria of from 3 △ to 5 △.

In Figure 10 (taken from Maddox, *The Clinical Use of Prisms*) is diagrammed an assumedly standard condition of affairs as to the sources of convergence innervation when binocular single vision exists at a close point, such as ten inches. The three grades of convergence are *tonic, accommodative and reflex* or *fusional.*

Tonic Convergence.

This has been marked in Figure 10 with a question mark (?) since it may be positive, nil or negative. The reader will recall the various methods—such as the Maddox rod test, the double prism method and so forth—for the finding of the equilibrium positions of each of the two eyes when looking at distance and when they are not forced to

engage in the art of binocular single vision. Hence exophoria in distant vision indicates a deficiency and esophoria an excess of tonic convergence. In distant vision, with accommodation relaxed, the tonic and reflex convergences only are involved in various tests. Excessive or deficient tonic convergences may be and in fact are generally associated with ocular conditions and habits which have previously involved either excessive accommodative action, as in hyperopia, or its reverse as in myopia. Hence this excess of convergence may occur after prolonged near work, in myopes who hold their work very near

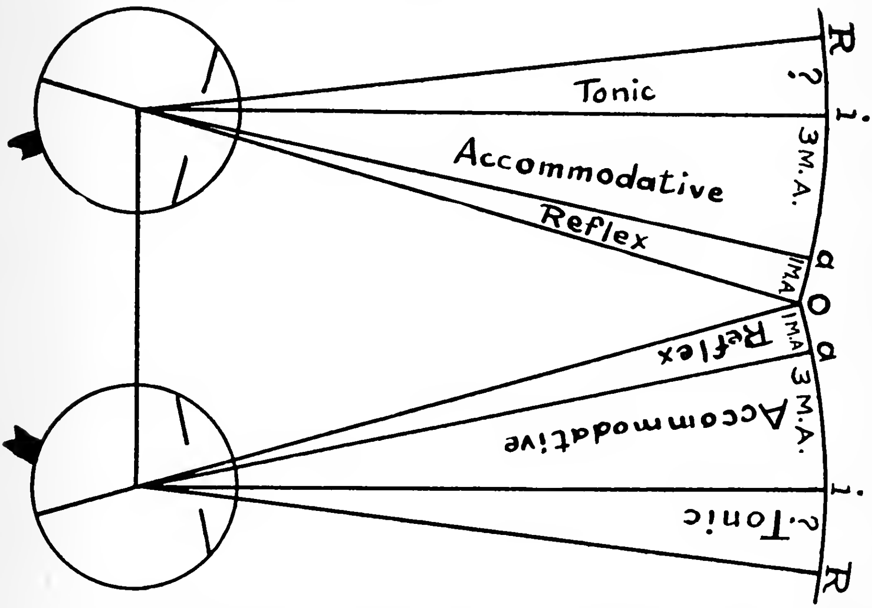


Fig. 10.—Illustrating the Three Grades of Convergence in Vision at Ten Inches. (Maddox.)

the eyes and yet maintain binocular fixation, and in most hyperopes, particularly when uncorrected. Asthenopia is the common sequela in such conditions. Deficiency of tonic convergence may be due to lack of muscular and nerve tone and is quite commonly found in myopia. It is probable that the most nearly normal *passive* or *tonic* condition of a pair of eyes, so tested as to destroy binocular single vision at distance, is one of about 2 △ to 3 △ of exophoria. In such conditions, therefore, binocular single vision ought to be obtained through the *reflex, supplementary* or *fusion* convergence—anyone of the foregoing three words referring to the same source or medium of convergence.

Accommodative Convergence.

In distant vision, when the accommodative demands are fully relieved, two kinds of convergence only can be involved, namely, the tonic and the fusional. In near vision, however, there is also normally present the accommodative convergence. For we know that an occluded eye will deviate inward when its mate changes its gaze from far to near points.

"As a rule," writes Maddox, "each diopter of accommodation is accompanied by three-quarters of a meter-angle of associated convergence, so that in a typical emmetrope, not presbyopic, the four diopters of accommodation in exercise for vision at a quarter of a meter are accompanied by three-meter angles of convergence, leaving a deficit of one meter-angle to be made up reflexly." To turn the meter-angles into prism-dioptries we may follow the Prentice rule which says: "Read the patient's interpupillary distance in centimeters, when one-half of it will indicate the prism-dioptries required to substitute one-meter angle for each eye." Hence for a P. D. of sixty millimeters with fixation at one-third of a meter, approximately eighteen prism dioptries are required, of which, following the Maddox principle, some thirteen prism dioptries are associated with the accommodation, leaving five prism dioptries to be fusionally supplied. We may therefore conclude that if the proper accommodative demands, both as to lenticular action and innervational supply, are being properly met, there will be exhibited at thirteen inches a physiological exophoria of four to six prism dioptries. This is equivalent to about 2 to 3 degrees of actual deviation or turning of the eyes from the position requisite for central fusion or binocular single vision, since the deviation produced by a prism is equal to about one-half of the number of prism degrees or prism dioptries refracting angle according to the formula that

$$d = (n - 1) A.$$

where n is the index of refraction, d the deviation angle and A is the principal angle of the prism. Should it be discovered that there is *less than five degrees* of physiologic exophoria, after due allowance has been made for the tonic convergence tests at twenty feet, we may conclude in general that there is an overtaxation upon or overstimulation of the accommodation as evidenced through its associated convergence and that, therefore, the accommodative action should be assisted by means of additional plus lens power, since a repression of innervation to the accommodation will thereby evoke a suppression of innervation to the convergence as associated with the accommoda-

tion and hence properly correlate the accommodation as associated with the accommodative convergence. Should the exophoria at near exceed six to eight degrees, due allowance being made for the tonic convergence as investigated at distance, it may be concluded that the innervation producing some definite accommodative action, whatever it may be, is not associated with convergence in such a manner as to produce the requisite or standard accommodative convergence, indicating, in some cases at least, that one diopter of innervation, to the accommodative mechanism produces more than one diopter of accommodation, and in other cases indicating the physiological absence of the association of convergence with the act of accommodation.

Certain ocular conditions will increase the amount of accommodative convergence. They are: (1) Cycloplegia from any cause, thus rendering the ciliary muscle less responsive to its innervations, demanding increased impulse to accommodation and thereby a proportionate increase of accommodative convergence. (2) If the object fixed be approached to the punctum proximum of accommodation, the effect produced in the lens is less than the impulse, so that the associated convergence produces an esophoria. (3) In hyperopia, without correction, the accommodative convergence is generally greater than under emmetropic conditions.

The conditions which lessen accommodative convergence may be summed up in one statement that anything which renders accommodation easier (where 1 D. of innervation produces more than 1 D. of lenticular change) or any condition which demands less than the normal accommodative effort for any specified fixation point (myopia) will lessen the accompanying accommodative convergence.

Fusion Convergence.

Since objects are seen single up to the punctum proximum of convergence and since tonicity tests prove to us that there may be a divergent or convergent excess, and the best experimentations by authorities upon these topics indicate that the association of convergence with accommodation is not complete centrally, there must be a fusion or reflex supplementary convergence operative in the interests of binocular single vision. We should expect, therefore, that fusion convergence would involve a greater waste of energy in the processes of coordination than the accommodative convergence which is associated with the act of accommodation. The fusion convergence at any fixation point is measured by prisms, base out, in testing the maximum of positive convergence and prisms, base in, in testing the maximum of negative or divergent fusion, the patient viewing an object such as

a line of type. We quote the following paragraph from Maddox: "The following table shows the fusion range found for varying distances in a man 32 with normal refraction * * *. The first column (A) gives the refracting angle of the highest (+), base out, and (—), base in, prism he can overcome at the various distances. The second column (D) shows the deviation of each eye produced by the aforesaid prisms; it is found by calculating the deviating angle of each prism, and dividing it between the two eyes * * *. The third column (R) gives the fusion range for each eye calculated from the figures in column (D). It will be noticed that both the positive and negative parts of the range increase as vision becomes nearer; also that the positive part exceeds the negative, though less so as vision becomes nearer."

TABLE SHOWING POSITIVE AND NEGATIVE CONVERGENCE RESERVES.

Distance	(A) Single Prism	(D) Deflection of each axis	(R) Fusion Range
6.0 m	16° : — 3°	4.5° : — 0.75°	5.25°
1.0 m	18° : — 8°	5.° : — 2.°	7.°
0.5 m	20° : — 12°	5.5° : — 3.75°	8.75°
0.33m	24° : — 16°	6.75° : — 4.5°	11.25°
0.25m	30° : — 18°	9.° : — 5.°	14°

The fusion convergence is the element most affected by ocular fatigue. We find it involved in so-called periodic squint. No squint may appear in the morning but as the labors of the day go on, especially if this involves much close application of the eyes, the vigor of the visual reflex diminishes until the amplitude of the reflex becomes less than the squint. If the patient is hyperope with excessive convergent tonicity and accommodative convergence it is entirely possible that the negative reflex convergence will be able to master it in the early hours of the day, but as the excessive strain is withstood hour after hour the effort will be abandoned, although there may be no squint at distance since the demands upon the fusion convergence are lessened at that point.

Clinical Methods of Testing the Accommodative Convergence.

Figures 11 and 14 show the forms of two varieties of test line which may be used for the testing of the convergence as associated with accommodation at any near point. In common practice these cards are inserted in the carrier provided with the phoro-optometer and sliding upon the rod thereof, or else the patient holds the card at

the desired distance from the eyes. This distance should preferably be that at which the patient's daily close work (occupational and reading distance) is done and for which lenticular assistance is chiefly required. Quite generally, unless there is a reason to the contrary, we make the test at thirteen inches.

One very important feature about these test objects is that each should carry a printed line of type with an accompanying indicator point such as the black circle in Figure 11 or the arrow in Figure 14. In the original von Graefe test object, of which the forms now presented are but modifications, a single dot or a ruled line only was used. Worth (*Squint* page 177) presents an acceptable form of test card carrying ten letters of "pearl" type having a large capital O in the middle. Worth likewise recommends the use of a card 2 feet square in order that the object shall be seen in the center of a blank field with no edges near to elicit fusion. In this respect the large size of card recommended may be superior to those used by us which have a size of about 5 x 6 inches. The purpose of the line of letters

● **Read These Words Letter by Letter**

Fig. 11.—Dot and Line Test-object for Use in the Accommodative Convergence Tests.

is to bring into play the accommodation, the evidence that such is the case being furnished the practitioner by having the patient read the letters or words. The viewing of a ruled line is an indefinite criterion. Hence, the two essential requisites in the accommodative convergence tests are: (1) the accommodation must be active and (2) the fusion convergence and anything which stimulates such a visual reflex must be annulled. The first of these is accomplished by having the subject under test read a line of letters; the second is secured through the use of vertical prisms of such amounts as to prevent the act of fusion of two or more images of the same subject into one.

The dot and line test card. Figure 11 shows the form of test object in which a heavy dot and line of type are employed. The Maddox double-prism, consisting of two prisms each of 4 △ ground base to base, is inserted before one eye, the patient wearing the full binocular distance correction as previously determined upon. The wearing of the distance correction is essential as we are desirous of knowing whether such corrections are compatible with, or in harmony with, the proper co-ordination of ocular functions. The double prism being inserted with base line horizontal before one eye, its mate being occluded, the position of the prism is so adjusted that the dots as pro-

duced by this device are seen in an apparently exact vertical line. The word "apparent" is used since the writer has found by making use of a considerable number of such prisms that the base line of the prisms has to be, in the majority of cases, tilted slightly downward temporally or upward nasally before the dots appear in a vertical row. A research upon this problem has been in progress for some time; we have found that there is some difference in the results dependent upon whether the card is held in the primary position or somewhat as in the general position usually assumed in reading, and

● Read These Words Letter by Letter

● Read These Words Letter by Letter

● Read These Words Letter by Letter

Fig. 12.—Images as Seen Under Fusional Dissociation Using the Maddox Double Prism.

have concluded that there is sound physiologic proof of a slight nasal extorsion above or intorsion below when convergence is in vogue. When, therefore, the two dots have been aligned vertically, the occluded eye is uncovered, when three dots and lines of type (No. 2 or No. 3 Jaeger type is used for the printed line) should be seen normally. The relative positions of these three dots, i. e., the position of the middle dot with respect to the first and third, constitutes the basis of our test upon the accommodative convergence. To be more specific; we generally insert the double prism before the left eye. The upper and lower lines of Figure 12 will then be seen by this (left) eye. The middle line is seen by the right eye; the location of the middle dot,

while the line of type is being read, gives the clue to the convergence as associated with accommodation. Suppose the middle dot is to the left of the upper and lower ones; we then have an ocular condition of exophoria indicated, since the images are crossed and, therefore, according to the law of the projection, that which is received upon the retina to the temporal side of the macula is projected into space to the nasal side, and so on. Suppose that the patient reports that the middle dot is toward his left eye and that we find that it takes 6 △ prisms, base in, to bring the three dots in alignment as nearly as possible. We conclude, then, that there are six prism dioptries (i. e., actually 3° of turning) of physiologic exophoria. The question is: How much convergence is associated with the accommodation? Taking the average interpupillary distance of 64 mms., with fixation at thirteen inches, or one-third of a meter, and applying the Prentice rule, it is found that 19 prism dioptries are actually (i. e., mathematically) required for binocular single vision at this distance. Since our assumed results on accommodative convergence have shown 6 prism dioptries of exophoria at this same point we conclude that the accommodative convergence amounts to 13 prism dioptries. This 13 prism dioptries is the difference between the 19 △ mathematically demanded and the 6 △ of deficiency. This is about two-thirds of the total convergence impulse which should be supplied by, or associated with, the accommodation. If it takes more than 6 △ prism, base in, to align the dots we should conclude that there was insufficient accommodative convergence (generally found associated with myopia) and if the dots are initially in a row, or the middle dot is displaced on the same side as the 'unprismed' eye, we should conclude that there was an oversupply of accommodative convergence and hence, generally, an abnormal demand upon the accommodation. Each case, however, must be taken upon its own merits and in the light of the remaining data obtained during an examination.

Hyperphoric conditions. Two additional tests which are of importance in the study of the conditions of poise of a pair of eyes are made possible under the procedure just described. These are: (a) examinations upon the vertical equipoise and (b) cyclophoria at near points. If there is a condition of vertical orthophoria the middle line will appear centered with respect to the other two lines providing the double prism is properly placed before one eye and the two prisms composing the testing piece are equal in power. The test for vertical orthophoria should be made while there is before one eye that prism which aligns the three dots vertically. The amount of prism, base up or down, needed to place the second line midway between the first

and third denotes the amount of hyperphoria or cataphoria present. The eye which does not wear the double prism is the one under test. When both distant and near-point investigations show a degree or more of vertical imbalance, at least a partial correction for the same should in general be given. It is an open question as to the procedure when there is no hyperphoria or cataphoria at 20 feet and when there is an appreciable amount thereof at the reading point. In prebyopic corrections the writer generally incorporates some optical assistance in the reading correction looking to the alleviation of such a heterophoric condition.

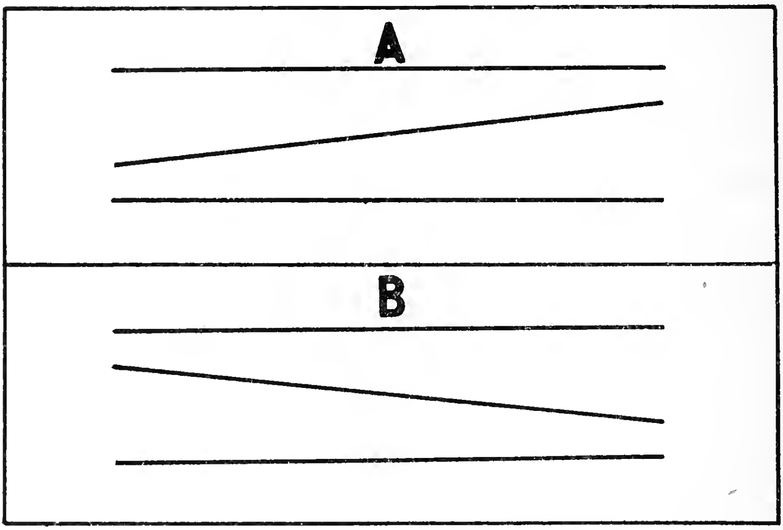


Fig. 13.—Illustrative of Cyclophoric Tests.

Cyclophoric conditions. The patient should be asked the question as to whether or not the three lines are parallel. We believe that this test should be made with the distance correction (or reading correction in case of presbyopia) before the eyes in addition to such prism assistance as will establish strictly orthophoric conditions at the reading point. There are cases in which a cyclophoria will disappear or be materially lessened when heterophoric corrections are given. These must be indicative of mal-attachments of the straight muscles involved. Such a statement as this is not contrary to the correct teaching that a cyclophoria *per se*—in which the oblique muscles are involved as in cases of oblique astigmia with diverging or converging axes—cannot be relieved by prismatic correction but only by cylinders (*vide* Savage's *Ophthalmic Myology* and *Neuro-Myology*).

In making the cyclophoric tests at the reading point, the double prism may be inserted before the left eye. The middle line is then seen by the right eye, which is under test. If all three lines are parallel no cyclophoria is indicated. If the middle line occupies the relative position shown in Figure 13. (A), in which the middle line dips toward the nose, a weakness of the right superior oblique, or right plus cyclophoria, is indicated. In Figure 13 (B) there is diagrammed the positions of the lines when the middle line dips toward the temporal side showing minus cyclophoria or weakness of the right inferior oblique muscle. The writer believes that, in general, these tests at near are of little value unless taken in conjunction with tests conducted with fixation at twenty feet (see DeZeng's *Modern Phorometer*, page 47-50). The procedure at distance involves the use of two Maddox rods so placed as to give two horizontal streaks when an 8 △ prism, base up or down, is inserted before the eye under test.

In making the test for cyclophoria at the reading point using the double prism method we have found the conditions diagrammed in Figure 13 (A) of almost universal occurrence. Tests upon subjects, such as engineering students, whose statements are reasonably certain of being trustworthy, indicate about 2° to 4° tilting when examined at the reading point. We have come, therefore, to regard this condition as practically physiologic and the normal condition of affairs when accommodation and convergence, with some subvergence in general, are exercised.

The line and arrow test card. Figure 14 shows a form of test line carrying a subjoined arrow. In practice a card, bearing these symbols, is used in the manner and at the distance stated in connection with the dot and line test. To produce doubleness of images there is ordinarily used a 4 △ prism, base down, in front of one eye and a like prism, but with base up, before the other eye. The two images of the test object will be seen in space displaced toward the apices of the prisms or away from the base. That is, if one prism is placed base down before the right eye, the upper of the two space images will be that viewed by the right eye, and so on. This arrangement of affairs, exhibiting the normal accommodative exophoria, is shown in Figure 15.

This form of test object is a modification of the Maddox tangent scale with subjoined arrow or of the Stevenson near muscle test. We are positive, however, that the results as obtained by these and similar devices are inaccurate as a general rule in the data which they furnish, for the reason that the head of one arrow and the tip of the other fall within the fusion areas of the eyes and that fusion is thereby stimu-

lated. This is certainly true if the fusion area measurements of Savage are correct and there is every reason to believe that his investigations upon this matter are substantiated. How often has the writer had the person under this test say: "Why I can bring the arrows over each other or not to suit myself." The explanation cannot lie

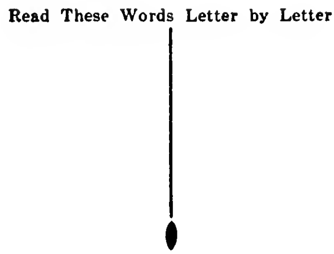


Fig. 14.—Line and Arrow Test-object for Use in the Accommodative Convergence Tests.

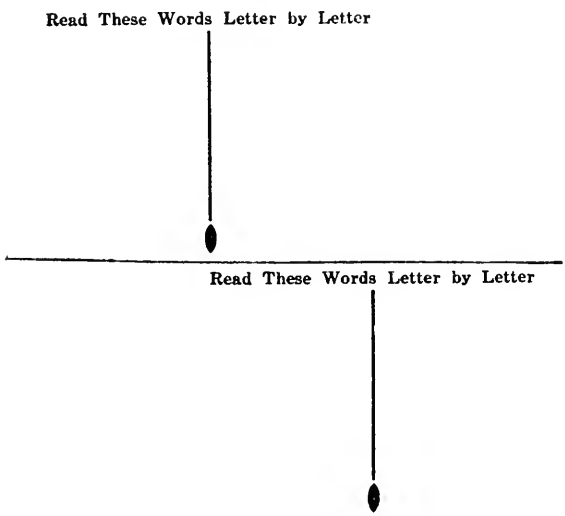


Fig. 15.—Doubleness of Images Under Fusional Dissociation Obtained by Prisms, base up and down, before each eye respectively.

in the presence or absence of accommodation and hence of accommodative convergence since the varying effects can be obtained when accommodation is uniformly enforced. The data carefully collected upon about five hundred subjects using the two methods—(a) dot and line and double prism and (b) line and arrow and prisms base

up and down respectively before each eye—show a greater degree of exophoria as well as a greater degree of esophoria by the first method than by the second. The great criterion in all tonicity and accommodative convergence tests is that fusion must be passive, i. e., one set of images must fall in toto outside of the fusion area.

Fusion Convergence.

The fusion range in near vision has been discussed in some detail in previous paragraphs of this chapter, and comments made upon the method of measuring the negative or divergent fusion by prisms, base in, at near points. The table which we quoted from Maddox, and which is, we believe, in a general way representative of the trend of the convergences at various points, clearly demonstrates that both positive and negative convergences increase in value as the fixation point is approached to the eyes. It is, therefore, evident that a distinction should be made between tests for distant vision, which normally involve practical parallelism of the visual lines and no accommodation, and tests for near vision where the visual axes converge and in which accommodation is involved. The writer believes from some experimentation he has been carrying on that in standard conditions the convergence as associated with accommodation becomes greater (i. e., there is proportionately less physiologic exophoria) as the accommodative demands are increased with approach of the fixation object by virtue of the fact that the innervation required to produce the last diopter of accommodation is somewhat greater than that required for the first diopter, hence giving increased accommodative convergence and alleviating the demands upon the fusion convergence, thereby indicating greater fusion convergence reserves at points closer to the eyes.

Figure 16 shows the form of object test which we use in fusion convergence (positive or negative) measurements at the reading point. It consists of a small card printed with a vertical row of letters set in 10 or 12 point capital letters. This card is handed to the patient and placed at the usual reading distance and the question asked as to whether only one line is seen. The answer will commonly be an affirmative one; if it is not, we are at once informed of the existence of diplopia at near points which will doubtless have been reported by the patient or else discovered by the examiner in his distance tests. The examiner then commonly turns in prism power until the maximum power base out is obtained through which a singleness of the line of type can be maintained. Such a test gives a measure of the *positive fusion* reserve in the interests of the prevention of diplopia at the

point under test. In general, the positive portion only is tested, through the medium of prisms base out. Wisdom in these tests seems to lie in a testing of the positive fusion convergence when tonic exophoria at distance and excessive physiologic exophoria, as associated with accommodation, are evidenced at the reading point, whereas the negative portion should be tried out in cases of high tonic esophoria and excessive accommodative convergence.

To measure the relative ranges of convergence similar operations to those described in preceding paragraphs are carried out, making use of prisms. The test card is placed at various points representing

KEEP THIS ROW OF LETTERS SINGLE

Fig. 16.—Test Line for Use in Finding the Amounts of Reserve Fusion Convergence at Near Points.

roughly integral meter-angles and prisms are placed before the eyes, base out to measure the positive, and base in to measure the negative, portions of relative convergence. For the average base line (64 mms.) the simplest way to convert degrees into meter angles (approximately) is to divide the number of the prism degrees by seven. The test object is a ruled line, or better a vertical line of coarse type. In the ordinary routine the amount of abduction and adduction are obtained at the far point; this may be considered as the relative range with accommodation relaxed. One then proceeds to the relative convergence at twenty inches, accommodation being exerted at one-half of a meter, and so on for as many points as described. If these tests at the reading point fit in in agreement with those at six meters, or-

dinarily no further regard need be given them; but in cases of exophoria and esophoria they are most valuable. We again note that normally about two-thirds of the convergence is associated with the accommodation at any point fixed upon. If, therefore, when reading at thirteen inches, accommodation and its associate convergence are normal, about 12 △ of convergence will be associated with the 3 D. of accommodation and since, assuming an interpupillary distance of 64 mms., some 18 △ of convergence are required, approximating 6 △ of fusional or positive convergence are demanded in order to complete the act of binocular single vision.

Such investigations as those we have been describing test, in reality, the *reserve* of fusion convergence. The criterion or basis for comfortable vision is taken as that laid down by Landolt in which he says that not more than one-third or one-fourth of the fusion range (amplitude) of convergence can be continuously in exercise for comfortable vision. If a line is seen single at the thirteen inch point we are then aware that the fusion convergence has been able reflexly to take care of the deficiency (positive or negative) of tonic or accommodative convergence or both. The adducting or abducting prisms which can then be added before a pair of eyes, with fixation constant, is a measure of the reserve convergence. If our premises as to accommodative convergence and reflex convergence are correct, the problem becomes one of simple arithmetic in any case as far as data are concerned. What to do in the nature of prismatic corrections, prismatic and other training exercises, lenticular refractive corrections and so forth is probably the most difficult problem in refraction. Let us assume for illustrative purposes two simple cases. Suppose that tests demonstrate a tonic exophoria of 5 △ and an accommodative convergence deficiency of 16 △ of which, allowing 5 △ for the normal physiologic exophoria, 11 △ represents the accommodative-convergence deficiency as compared with the assumed standard. At least 16 △ of reflex or fusion convergence are demanded in binocular single vision at thirteen inches, while the total demand fusionally (including the tonic) and accommodatively is about 23 △. Let us further assume that the positive fusion reserve at thirteen inches is 20 △. The data show, therefore, a constant fusion demand of 16 △ at thirteen inches and a reserve of 20 △. Vision at near points under such circumstances is likely to prove comfortable unless engaged in for too long periods of time. Or again: a certain case shows a tonic error of 2 △ of exophoria, the accommodative convergence test shows a lack of 14 △ to give central fusion, while the *positive* fusion reserve is 5 △ only and the negative reserve is 25 △. Such data as these show that the total

positive fusion amplitude at thirteen inches is 21 △ (i. e., 2 + 14 + 5 △) of which over two-thirds is in constant demand. Such a pair of eyes would have difficulty in maintaining binocular single vision and certainly would experience asthenopia in the attempt. As another illustration, let us assume a tonic esophoria of 4 △, an accommodative convergence of 20 △ (i. e., 18 △, or the average at 13 inches, plus 2 △ of overconvergence: this might be recorded as 2 △ *base out* at 13 inches), a positive fusion reserve of 30 △ and a negative reserve convergence of 10 △. In this case there is overconvergence accommodatively and, if we should assume a physiologic exophoria of 5 △ at thirteen inches, taking into account the esophoria at distance, we should say that the accommodative convergence was at least 7 △ in excess of what the standard relations of accommodation, as associated with convergence, demand. At any rate there is very good evidence to indicate that the accommodative needs demand attention through the prescribing of convex lenses, at least for close work. In this particular case, since overconvergence occurs through the accommodative act, this creation of energy must be counteracted by neuricity to the external recti to produce binocular single vision, and this demand is met by the negative fusion centers. This accounts physiologically for the soreness and pain commonly experienced in such cases in the temporal and zygomatic regions.

The writer agrees with Maddox when he says that the view that all squints are due to central fusion defects *only* is untenable. "Were it true, all squints would date from birth, whereas it is a matter of common knowledge that a very large proportion date from the age of three years, after binocular vision has been enjoyed for some time. Moreover, they generally commence in near vision only or when the attention is concentrated upon an object. This proves that single vision is sufficiently appreciated to overcome gentle obstacles, but the faculty of fusion divergence is not sufficiently developed to conquer the strong impulse to convergence which accompanies the excessive accommodative impulse in hypermetropia." (*The Clinical Use of Prisms,* page 175).

If, therefore, there is excessive accommodative convergence and if the hyperopia generally present is fully or even slightly overcorrected (such overcorrections are very acceptable in close work) the tonic convergence will slowly tend to become less and the diverging centers will no longer be forced to function abnormally because of the excessive accommodative action and the associated accommodative convergence. Squints (high phorias) are thus often relieved and approximately normal convergence and accommodative relations established by the wearing of proper lenses.

In cases of myopia, in which exophoria exists in both distant and near vision, an analysis similar to that which we have given above will show that the amount of positive fusion convergence demanded at near points is generally excessively large. The drain is therefore upon the positive fusional innervation; if this is unable to bear the load efforts to maintain binocular vision may cease and divergent strabismus ensue. When, however, the myopia is corrected, in part or in whole, accommodation is made active and the positive convergence associated with accommodation then enters as a factor to aid in the relief of the burden carried by the fusion convergence.

These analyses give a logical basis for the explanation of why all hyperopes do not have convergent squint and all myopes do not have divergent squint. For strabismus will not occur when the amount of either positive or negative fusion convergence demanded can be supplied and leave in addition an adequate reserve. The whole of the convergence is not supplied through the innervation associated with accommodation but the deficit is made up where possible through reflex convergence. Assume, for illustration, a case of myopia of 3 D. with an exophoria of 3 △ at distance. Assume, further, an interpupillary distance of 64 mms. and that fixation is at 13 inches. A simple calculation shows that 20 △ of convergence is demanded for fixation at this point: of this amount the convergence associated with accommodation furnishes nothing since the accommodation is nil. The fusion convergence must, therefore, under the conditions assumed, supply about 23 △ of positive convergence in order to compensate for the losses occasioned by the tonic, accommodative and normally demanded fusional convergences. The whole responsibility for binocular vision is thrown in large measure upon the fusional centers and these may be unable to comfortably supply the demand and divergent strabismus therefore develops. If, again, we assume that the full error is corrected and hence 3 D. of accommodation demanded and produced at the near fixation point, then approximately 13 △ of the convergence ought to be supplied through the accommodation convergence and leave but 10 △ to be cared for through the medium of reflex convergence.

Ordinary Duction and Version Tests and their Significance.

Distance duction tests. The remarks which follow as to the value of the ordinary duction tests as made at twenty or more feet are introduced by a paragraph taken from Savage's essay on *Ocular Muscles* contributed to the tenth and eleventh volumes of this *Encyclopedia.* Savage writes: "There are three tests which should be made of every

pair of eyes as a part of the work of refraction. To neglect the making of these tests will mark many failures against the oculist. Tonicity, duction and version are the names of these tests. The two first mentioned are indispensable; the last one named is of such value as to command attention. In a very crude way the tonicity and fusion tests may be made with the loose prisms in the refraction case, but better far is the monocular phorometer. The binocular phorometer should not be used for either of these tests, for the fundamental reason that the image of the test object in one eye should be undisturbed. The principle on which all the tests possible to a phorometer rest is that the image in one eye, throughout every test, shall be undisturbed, that the head shall be erect, and that both eyes and the object—better a white dot on a black background—shall be on the extended horizontal plane of the head. The false object must have its image thrown outside the area of binocular fusion in the eye under test * * *.''

In the writer's opinion, however, many of these tests are not as valuable to the refractionist as are the tonicity tests conducted at twenty feet when taken in conjunction with the findings upon the accommodative amplitude, the convergence, as associated with the accommodation and the fusional convergence at the reading point or thirteen inches. These distance tonicity, duction and version tests do, however, form a valid basis for the determination of whether or not innervations or strengths or attachments of muscles are at fault since, in general, practically normal duction and verting powers indicate—in cases of tonicity excesses or lack of proper coordination between accommodation and convergence—innervational excesses or deficiencies and not inherent muscle abnormalities. For instance, if tonicity tests indicate several degrees of exophoria, adduction powers considerably below the normally accepted three to one ratio as compared with abduction, and adversion low or abversion excessively high we may with reason conclude that there is a muscular rather than innervational deficiency of the interni. It is, however, to be remarked that duction tests at 20 feet, with the patient wearing his full distance correction, presume that positive or negative convergence, and so forth, are exercised with the function of accommodation passive. Such duction tests conducted at distance must, therefore, be a measure of the ability of the fusional centers, wholly independently of accommodation, to overcome the tonicity defect (or be aided by it, dependent upon whether this equilibrium condition is one of exophoria or esophoria) and to maintain binocular single vision.

Viewed in a certain way it appears plausible that the amount of an exophoria, for example, should be added to the adduction (or sub-

tracted from the abduction) as determined by prisms with fixation at distance. Or again, the amount of an esophoria should be added to the abduction (or taken away from the adduction). This, in each case, for the reason that the abductors, for example, must first overcome a tonic condition of esophoria and as a result there is a demand upon the fusion centers, specified as abduction, which must be exerted before binocular single-vision can ensure. The remainder of such a test, namely: the adduction—accomplished by prisms base *out* in the particular case cited,—is simply the *negative reserve fusion.* It cannot, of course, be claimed that such is absolutely so, but it seems a much more logical view than to simply fail to give any reasonable explanation of the connection between the tonicity tests and duction tests. To say, for example, that the adduction and abductions should bear a relation of one to three to each other, is about as arbitrary as to say that all convergence should come associated with the accommodative act. The notions which all of us possess on these topics need some radical revisions without doubt; untruths will doubtless be written many times before the truth prevails. And surely we may be pardoned an unkind remark with respect to the mystical "three-to-one" ratio which seems to run through so many of our writings and so much of our teaching.

But to return to a simple illustration: Data show that there is a tonic error of 3 △ exophoria: the abduction is 8 △ and the adduction is 12 △ as obtained with the use of rotary prisms. We find the data so recorded in a case of myopia having a manifest error of one-half diopter; the tests were made while the person under examination was wearing correcting lenses. The question is: Do these duction tests give, as recorded above, a true measure of the ability of the fusion centers to maintain binocular single vision at distance? The writer answers: No, and believes that the abduction should be recorded as 8 △ and the adduction as 15 △ (i. e., 12 △ + 3△). In this case, then, no attention need be paid to the abduction. The adduction showing 15 △ and having to counteract an exophoria of 3 △, thus having a reserve of 12 △, is ample for comfortable binocular single vision at distance.

If, again, it is assumed, as so many writers do, that convergence and accommodation are so closely related that the accommodation and accommodative-convergence points are one and the same, then the duction tests at infinity are presumed, it seems to the writer, to measure simply the power of the fusion centers to overcome tonicity deficiencies and to supply any needed positive or negative convergence, if such is needed, at near points. We do not, therefore, as a

general rule, take the duction and version tests unless the tonicity tests show large error, but are prone to depend in general upon the disclosures at the reading point. And again, one of the inflexible rules which must underlie the investigation of any given ocular function is "that such investigations must be conducted under conditions of activity and quiescence which conform to the philosophy of the particular phase of its activity under consideration." Convergence demands are normally made and met at points inside of infinity (practically 20 feet). Maddox, to the writer's notions, comes nearer the true method when he writes:—"To measure more accurately, we should first discover the near point of accommodation, and while looking at an object at that distance from the double rotating prism frame, rotate the edges of the prism inwards until diplopia commences. By adding the maximum convergence thus found to the already ascertained prism-divergence for distance, we get the 'absolute range (amplitude) of convergence' of which, according to Landolt, *not more than one-third or one-fourth can be continuously in exercise for comfortable vision."*

The monocular tonicity and duction tests are most valuable, however, in locating the single weak muscle of a pair of muscles and often show that the ductions of the extrinsic muscles of one eye are normal while the abduction, adduction. superduction or subduction of its mate are faulty. Hyperophoria and hypophoria are relative conditions corrigible by prisms base up before one eye or base down before the other, or *vice versa,* or the prismatic assistance may be divided between the eyes. Vertical imbalances are generally of much greater importance than are the lateral imbalances and greater care and skill are demanded in their optical treatment than in low degrees of exophoria or esophoria; it is, therefore, very essential that the weak ductioned muscle or muscles be determined in order to logically proceed to its alleviation through optical assistance in a manner such as will tend to restore its normal functions where possible. Since the duction powers of the vertical muscles are low, great care needs to be exercised in their treatment; if such is true, the writer believes that some auxiliary device should be provided in our modern phorometers in order that our vertical ductions may be determined with more certainty than is possible with our present rotary prisms in which the prismatic power changes are too rapid for the small amount of mechanical motion involved.

And, again, the vertical imbalances which may be found at distance should be investigated carefully at the reading point, since they may exceed those found at distance or may, on the other hand, almost if not entirely disappear at close range. Such conditions at the reading point clearly indicate the presence of mal-attached muscles or the

existence of a genuine vertical imbalance in the first instance; and the probability, in the second case—should a small imbalance at distance but found to be non-existent in close point tests—of the inaccuracy of the distance findings. It is a rather good test, therefore, to take a single black dot (or a dot and line of type) as shown in Figure 11, and to get the superduction and infraduction of both eyes at the reading point. If the ductions are unequal in each of the two eyes and are unsymmetrical in each case, then a genuine vertical imbalance is indicated and the need of optical assistance pointed out. To illustrate this point, we shall assume a condition showing 2 △ of right hyperphoria. The ductions at twenty feet might, then, well be as follows: O. D. superduction 6 △, infraduction 3 △, O. S. superduction 3 △, and infraduction 6 △. At thirteen inches the data might be of this nature: O. D. superduction 7 △, infraduction 4 △, and O. S. superduction 4 △ and O. S. 7 △. The exact repetition of quantities as given above is not likely to occur, but the variations will be small and, in general, of no great consequence. Furthermore, the values of the ductions at distance and at close testing points are very often different, but the difference between the superduction and infraduction at the two points of investigation remain the same in vertical imbalances due specifically to malfunctioning superior and inferior recti muscles.

Version tests. The rotations in the four cardinal directions are those to be studied. The best instrument for these tests is the tropometer of Stevens (*vide* Stevens, *The Motor Apparatus of the Eye*). A very satisfactory test may, however, be made with the perimeter and the small electric lamps of the ophthalmoscope. The patient should be placed in front of the perimeter while the eye to be tested must be at the center of the perimetric curve. The patient's head should be then kept immobile. The extent of the abversion is determined by having the subject fix the small electric lamp as it is moved behind the perimetric arc or arm toward the temporal side of the eye under test. When maximum version has been produced the operator places the lamp so that the lamp image occupies the center of the rotated cornea and reads the degree mark on the perimetric scale opposite the luminous source used. The rotation in the opposite direction, or the adversion, can be obtained in like manner. With the perimeter arms vertical, the extent of the upward and downward versions can be determined. Both eyes should thus be tested. The extent of the versions under normal conditions as given by different authors varies somewhat. Landolt gives: Out 46°, in 44°, down 50°, up 33°. Stevens' standard, which is probably nearer correct, gives: Out 48° to 53°, in 48° to 53°, down 50°, up 35°. A muscle that has the normal fusion

or duction power should also have normal verting power and in general, when one is abnormal, the other is likely to be abnormal also.

The Great Ocular Problem—The Economic Coordination of Accommodation, Accommodative Convergence and Fusion Convergence.

The above caption expresses the view that we have been dealing in this chapter with the most vital problems in the economy and comfort of the ocular regime. When shall prisms be prescribed and when not? When are prismatic or natural exercises likely to be of any avail? When should maximum or minimum convex or concave lens be prescribed? When is operative interference necessary? It would take a volume to answer these questions: they would not then be solved. In brief we state the following answers. Anatomical defects can be altered by operative interference, the tonic position by prisms, the accommodative convergence by lenses and the fusion convergence by any of these. The tonicity may be, however, and generally is, associated with accommodative defects and the results under proper refractive corrections should be tried and time allowed for a readjustment before the insertion of prisms in the prescription. Suppression or stimulation of the accommodation, and thereby the associated accommodative convergence, should be indulged in whenever various tests upon the accommodative resources, fusion convergence and so on, show that the function of accommodation is operating under conditions in which the effort is disproportionate to the work. In this group fall accommodative squints and cases in which the squint appears only in near vision. Prisms can be of no service in the correction of such conditions as these, *per se,* since there is no logic in allowing an over-convergence to occur, for example, and then endeavoring to kill or annul its action by means of prisms. Of necessity the burden in binocular vision in such conditions must fall upon the negative fusion convergence and this may be temporarily aided, if deemed best, by the use of prisms base *out*. The writer, however, does not believe in the use of prisms for permanent wear in persons under *forty* except as a last resort.

The fusion convergence may be altered by operation, lenses, or prisms. If the proper accommodation-convergence relations can be re-established it will be found that, very frequently, the problem will be solved. Attempts at training the fusion convergences, particularly a weak positive fusion, should always be made in persons under thirty-five to forty. The simple "finger toward the nose" exercise over a period of some weeks will work marvels in many cases. The difficult problems are those in which the accommodative needs, for example,

demand that convex lenses be prescribed, while all the accommodative convergence and fusion convergence tests (in particular) show that the reflex convergence is low. In such cases we are prone to give corrections involving proper lenticular assistance to the accommodation coupled with low prism (1 △ to 2 △) base in over each eye. The writer feels that prisms base *in*, when indicated, are of much greater ocular service than are prisms base *out* when prescribed. As a general rule prism and other exercises are of little avail in persons of middle-age and beyond, hence these very important tests should be made and great nicety of judgment exercised in the correction given when low fusion convergence reserves are found at the reading point.

In concluding this chapter, which has dealt with some of the important problems of ocular refraction, the reader must be satisfied with the citation of a few illustrations from our own record.

Case 1. *Low positive fusion reserves at both distant and near points.* Mrs. M. C. B. Has slight drooping of lid of left eye. Cannot read newspapers except at *close* points. Has diplopia occasionally, she reports. No headaches, no soreness of eyeballs, etc. Eyeballs become inflamed after reading. *Static skiametric* tests showed: O. D. + 0.75 D. S. ⌒ + 1.00 ax. 90, O. S. + 0.25 D. S. ⌒ + 0.75 ax. 90: the *dynamic skiametric* examination with fixation and observation at 13 inches gave O. D. + 1.50 D. S. ⌒ + 0.75 ax. 90 and O. S. + 1.00 D. S. ⌒ + 0.75 ax. 90. This difference, if due allowance is made for the half diopter of extra plus lens which we feel to be normally found by dynamic skiametry, is negligibly small and indicates, *per se*, that the accommodative needs are amply met. *Subjective tests* gave O. D. + 1.00 ⌒ — 0.75 ax. 180, V = 30/30 and O. S. + 0.75 ⌒ — 0.75 ax. 180, V = 30/30. Binocularly, the spheres could be increased to + 1.25 and + 1.00 respectively. *Monocular objective accommodative* tests showed 7 diopters in each eye: binocularly 8 diopters. *Concave-at-near* tests showed a monocular subjective amplitude of 8 diopters. The *tonicity* tests, the patient wearing the subjective findings, evidenced 1 △ exophoria. *Duction* tests gave: adduction 8 △, abduction 8 △, superduction 4 △ and infraduction 4 △: evidently the adduction is relatively low. The *accommodative convergence* test indicated 7 △, base in, to align the dots: hence practically 12 △ of convergence were associated with the accommodative act. The 7 △ of deficiency had to be obtained from the fusion centers. The *reserve positive fusion* was found to be 8 △ as a maximum and the *negative reserve fusion* to be 20 △. The chief source of trouble in this case, other than the condition of compound hyperopia—which had been

largely cared for by the wearing of glasses for some years—lay in the fact that the total fusion convergence at 13 inches amounted to 14 △, of which about half was in constant demand. Hence difficulty in obtaining and maintaining the act of binocular single vision occurred, especially toward the end of the day. Furthermore, when an ophthalmoscopic lamp was fixed and approached toward the patient's eyes, binocular single vision ceased at about seven or eight inches, the left eye invariably assuming the divergent squint. This woman was referred for a thorough systemic examination; reports being negative, she was given for general wear: O. D. + 1.12 D. S. ○ — 0.75 ax. 180 and O. S. + 1.00 D. S. ○ — 0.75 ax. 180; and for reading O. D. + 1.37 D. S. ○ — 0.75 ax. 180 ○ 2 △ base in. O. S. + 1.25 D. S. ○ — 0.75 ax. 180 ○ 2 △ base in. The "finger toward the nose" exercise was also instituted. Reports evidenced ocular comfort and recent tests indicate that the fusion reserve is about a half as much again as in the initial examination.

Case 2. *Hyperopia with periodic squint.* Mr. S. G. 21 years. Has frontal and temporal headaches; eyes sore and burn; print blurs "when he reads in a certain way" (probably binocularly); has had diphtheria and scarlet fever. *Static retinoscopic* tests showed O. D. — 0.25 D. S. ○ + .50 ax. 90, O. S. — 0.50 D. S. ○ + .37 ax. 90. *Dynamic skiametry* evidenced at thirteen inches O. D. + 1.75 ○ + .50 ax. 90 and O. S. + 1.37 ○ + .50 ax. 90. Note the marked difference between the static and dynamic findings. *Subjectively* O. D. — .37 D. S. ○ + .50 ax. 90 and O. S. — .50 D. S. ○ + 37 ax. 90 (each eye equally good), did not give better than V = 8/10 monocularly or V = 20/20 with difficulty binocularly. With these corrections the patient's muscular equipoise at 20 feet showed, under the binocular *tonicity test*, 8 △ of esophoria; cover test, either eye, showed a redress of about 1 mm. out. *Monocular tonicity tests* disclosed that the major portion of the esophoric tendencies resided in the left eye. The *accommodative-convergence* tests evidenced 15 △ of esophoria (over and above the allowance for the 6 △ of physiologic exophoria). The various *subjective accommodation* tests at 13 inches evidenced about 9 D. for each eye. The *negative fusion convergence reserve* at 13 inches was 6 △ or relatively nil. The *duction* tests at 20 feet evidenced for each eye the following: abduction 3 △, adduction 30 △. Our analysis of the case is that there is marked evidence of: (1) anatomical defect, (2) excessive accommodative convergence, (3) insufficient negative fusion reserve. We prescribed the following: (1) medical examination and assistance, (2) abduction exercises recommended

by Thorington (*Methods of Refraction,* pages 275-277), (3) reading correction: O. D. + 1.25 D. S. ⁀ + 50 ax. 90 ⁀ 1.5 △ base out and O. S. + 1.12 D. S. ⁀ + .37 ax. 90 ⁀ 2 △ base out, (4) distance correction, O. U. + .37 ax. 90 ⁀ 1.5 △ base out giving V = 8/10, initially more unsatisfactory to patient than no cylindrical correction. The patient reported perfect ocular comfort over a period of six months.

Case 3. *Excessive accommodative convergence.* This case is typical of a set of ocular conditions which are occasionally found in practice, in which there is apparently either no refractive correction for distance or such a weak-powered sphere as to be negligible, but in which assistance is demanded when reading and working at the usual distance are engaged in. The young man in question was a university student, twenty-one years of age, a student of law and accustomed to long hours of close application to his books. He reported no symptoms other than an apparent fatigue of his eyes. The *static skiascopic* examination revealed a neutral shadow condition and at times a slightly myopic motion; no convex lenses could be added without producing a decided reversal of shadow. *Subjectively* no distance correction was found; monocularly a quarter of a diopter convex lens was rejected as making the twenty foot line unreadable; binocularly this line was readable through quarter diopter convex spheres. The *dynamic skiametric* findings, with observation and fixation at thirteen inches, showed a decidedly "with" motion and + 1.25 D. S. before each eye was needed in order to produce neutrality. The *duction* tests at twenty feet showed abduction 7 △, adduction 20 △, superduction 2 △ and infraduction 2 △, indicating normal duction or fusion powers at the distance for which the test was made. The Maddox rod test at twenty feet evidenced no muscular imbalance. But the *accommodative convergence* tests at the reading point, using 4 △ prisms base up and down before each eye respectively and the line and arrow card, showed the arrows directly over each other, indicating an accommodative over-convergence or, at least, full convergence as associated with accommodation, while the double prism and dot test showed 4 △ base *out* with no vertical imbalance or cyclophoria at near. The *accommodative amplitude* was determined as 8 D. for each eye by the concave lens method of testing this function at thirteen inches. This young man was given O. U. + 1 D. S. for reading, wholly in the interest of the proper correlation of accommodation and convergence at the reading point. It may be pointed out with profit that if the practitioner had depended solely upon the distance objective and subjective findings and upon determining the amplitude of accommodation by the method

commonly in vogue, i. e., the distance from the eye at which No. 2 Jaeger type can be read both monocularly and binocularly, he would have been logically forced to conclude that these eyes needed no assistance; but determinations by dynamic skiametry and by investigating the conditions at the reading point with accommodation active, fusional convergence passive but accommodative convergence active, clearly indicated the need of lenticular assistance and the reason why.

Case 4. *Weak positive convergence.* This extremely interesting case of actual excessive accommodation with a low degree of astigmatism is presented in some detail as it illustrates that condition of affairs, only too frequently found, in which the patient was wearing minus cylinders at axis 180° when plus cylinders at axis 90° were really demanded and ultimately accepted. In this connection the reader is referred to Howe's *Muscles of the Eye*, Vol. II, page 26 *et seq.* The young lady in question came complaining of nausea, headaches and inability to do close work with any comfort. She had typhoid fever five years ago and her ocular trouble dated from that time according to her statement. A preliminary ophthalmoscopic examination showed congestion or hyperesthesia of the retina. The general appearance of the patient was anemic. She was put under medical treatment at once. The ocular examination evidenced the following results at the first examination. *Static retinoscopy,* O. U. — 0.25 D. S. ⌒ — 0.75 cyl. ax. 180. *Subjectively* this could be made O. U. — 0.75 cyl. ax. 180 with slightly blurred distant vision (V = 8/10). *Dynamic skiametric tests* were very erratic but indicated in general O. U. + 0.75 cyl. ax. 90. Such a result with dynamic skiametry is frequently to be looked for, since the method generally indicates increased convex lens power as compared with the static skiascopic findings. The *tonicity tests* indicated orthophoric conditions. The *accommodative convergence,* wearing the distance corrections, evidenced 4 △ of over-stimulation. The *accommodative tests* indicated 9 D. for each eye by the concave-at-near method. The *positive fusion convergence reserve* was not in excess of 6 △. In fact, as a pencil was approached toward the young lady's eyes, she winced and exclaimed: "Do not do that again; it makes me sick." The cause of the inability to do near work and the general cause of the ocular discomfort therefore resided in this weak fusional convergence. We examined the correction she was wearing, prescribed about two years previously under a cycloplegic according to her statement, and found that they exactly incorporated our static findings which the writer was certain were incorrect. Prismatic exercises were instituted and we had the patient carry out the "finger

toward the nose" exercise for a period of two weeks. *Dynamic skiametric tests* then evidenced O. U. + 1.00 D. S. ⊃ — 0.75 cyl. ax. 180. *Subjectively* we were able to force on by degrees O. D. + 0.87 D. S. ⊃ — 0.75 cyl. ax. 180 and O. S. + 0.50 D. S. ⊃ — 0.75 cyl. ax. 180, giving equal visual acuity and binocularly affording the patient V = 8/10. The patient was given O. U. + .62 cyl. ax. 90 and the exercises continued for a period of two months, when the *reserve fusion convergence* at 13 inches tested up to 16 △. At the present writing she is wearing O. D. + .50 D. S. ⊃ + .75 cyl. ax. 90 and O. S. + .37 D. S. ⊃ + .62 cyl. ax. 90. Tests show no *tonic* errors at distance, proper co-ordination between accommodation and convergence and plentiful fusion convergence. She had relief from the symptoms of which complaint was made.

Case 5. Mr. E. Aged 35 years. History of melancholia, uncertainty in gaze and walk, very nervous. Severe headaches and so forth. Various tests showed that O. D. + 1.00 D. S. ⊃ + 0.50 cyl. ax. 75 and O. S. + 1.25 D. S. ⊃ + 0.37 cyl. ax. 105 gave normal and equal acuity. The *binocular tonicity tests* showed 9 △ exophoria and 4 △ left hyperphoria. At thirteen inches various tests showed 12 △ exophoria and 4 △ base up O. D. The *ductions* evidence: O. D. abduction 9 △, adduction 15 △, supraduction 1 △, infraduction 2 △; O. S. abduction 11 △, adduction 14 △, supraduction 2△ and infraduction 1 △. *Version tests* did not prove out satisfactorily or consistently; *adversions* apparently weak in both eyes, however. The *reserve fusional convergence* at thirteen inches was approximately 5 △, but this was erratic in character. Tests upon the *accommodation* disclosed a practical paresis thereof. We were entitled, then, from the above data and his history, as well as from other data not here recorded, to diagnose an involvement of the third nerve. He was referred to a neurologist. This he did with the report that the statement had been made that his hay-fever of long years standing had apparently involved the sinuses. To afford as much ocular comfort as possible we gave him, in addition to the sphero-cylinder corrections both for distance and near, the following: O. D. 2 △ base in, 1 △ base up and O. S., 2 △ base in, 1 △ base down.

Case 6. Mr. A. W. Age 25 years. A teacher by profession. Has been examined previously and been told that there was no accommodative, refractive or astigmatic errors. Tests previously made under a mydriatic disclosed little spherical correction. Has, however, uncomfortable coordination of his eyes.

Static retinoscopy disclosed no refractive errors and *subjective monocular* and *binocular tests* failed to elicit comfortable vision under low powered spheres. *Dynamic skiametry* disclosed O. U. + 1.00 D. S. In the prescriptions finally given this young man, one prescription involved a reading correction of O. U. + 0.75 D. S. combined with the distance prismatic correction to be disclosed later. *Binocular tonicity* tests showed 5 △ of exophoria and 3 △ of left hyperphoria. The duction tests demonstrated the following:

DUCTIONS.

O. D.		O. S.	
Abduction	4 to 6 △	Abduction	8 △
Adduction	8 to 10 △	Adduction	12 △
Superduction	1 △	Superduction	4 △
Subduction	4 △	Subduction	1 △

The *version tests* showed:

O. D.		O. S.	
Abversion	48°	Abversion	50°
Adversion	42°	Adversion	46°
Superversion	27°	Superversion	45°
Subversion	55°	Subversion	35°

Tests at the reading point showed 14 △ of exophoria and 3 △ of left hyperphoria. The fusional reserve convergence at the reading point was about 10 △.

The data, we feel, indicate that the true *abduction* is 4 to 6 △ and the true *adduction* 13 to 15 △; that the *positive fusion convergence reserve* at the reading point is low, and that there is a genuine vertical imbalance at both far and close points. The *version* tests show that the verting powers of the externi and interni are about normal, but that there is a decided abnormality in the case of the superior and inferior recti. For distant use we therefore prescribed: O. D. 1 △ base up ⌒ 1 △ base in: O. S. 1 △ base down ⌒ 1 △ base in. Furthermore, there were instituted prismatic exercises and the simple toward the nose movement of the finger in order to restore normal lateral equipoise but without success. The glasses, according to the prescription written above, the patient has worn with perfect comfort and ocular coordination for several years. In the record of the case we find the note that when the above corrections (slightly increased, however) were worn there was no cyclophoria present but that without such corrections several degrees of cyclophoria were apparently exhibited.

Chapter VI. Cases illustrating various dynamic ocular tests.

Full and accurate data should be preserved in every case examined. The keynote to the efficient and proper examination of the eyes is expressed by the word *method*. With a complete case history and a full record of the data and conclusions, the practitioner is *master of his practice* and will inevitably, if of the truly scientific trend of mind, discover facts away from the beaten paths. It is probably in this way only that we may hope to find the average busy practitioner making his contributions to ocular science.

Outline of the Routine.

The outline of the routine should include most, if not all, of the following tests. Speed of, and in, examination is no criterion in ocular work.

History.

1. Ophthalmoscopic, external eye examination: blood pressure, etc.
2. Ophthalmometric examination and record of findings.
3. Static skiascopic findings.
4. Dynamic skiametric findings.
5. Objective amplitude of accommodation tests, both monocularly and binocularly.
6. Subjective tests with corrected and uncorrected visual acuities.
7. Comparison tests, as to equality of acuity at distance and near points, person under test wearing correcting lenses.
8. Tonicity tests: both monocular and binocular.
9. Duction tests of the recti muscles.
   Monocular tests on the oblique muscles.
   Duction tests of the oblique muscles.
10. Accommodative convergence tests at the reading point.
    Tests for cyclophoria and hyperphoric conditions at the reading point. (This test may be carried out in conjunction with test No. 10.)
    Subjective monocular and binocular near points by reading charts.
11. Subjective accommodative tests, using concave lenses, at the reading point.
12. Reserve fusion convergences—positive and negative—at the reading point.

℞ No. 1231 Name Doe, Mrs. John Date March 1, 1919

Occupation Housewife City 17006 Main St Age 25 years

Phone No. Street No. Columbus Ohio Call Again

		SPH	CYL	Axis	Prism	Base
Distance	O.D.	+1.12	-0.75	180	1△	IN
	O.S.	+1.00	-0.75	180	1△	IN
Reading Total	O.D.	+1.50	-0.75	180	1½△	IN
	O.S.	+1.37	-0.75	180	1½△	IN

Size of Eye 000 SO

Frames

Frameless ✓

Windsor

Hole for cord Yes No

PD	Height	Position of Crest	Angle of Crest	Width of Base	Temple Length	Bridge No.
2½"	+1/16"		40°	3/4"	5½'	

Decenter	Width between Temples	Segments

Spectacles—Frames—Frameless

Frames

Lenses

Case

Cost

Price

Nose Glasses—Frames—Frameless

Mounting

Lenses

Case

Cost

Price

Bifocals

Cement Style

Opifex

Perfection

Kryptok

Ultex

Separate Pairs for distance and reading

Tint: Crookes, Noviol, Amber

REMARKS

Main features of case:-

1) low adduction at 20 feet

2) low positive reserve fusion at 13 inches.

Note: Approaching ophthalmoscopic lamp toward eyes— binocular single vision ceases at about 7 inches—Left eye invariably assumes the divergence.

X1

Devised by Charles Sheard, Ph.D., Professor of Applied Optics, the Ohio State University, Columbus, Ohio.

Fig. 17.—Sheard's Form of Record Card. (Mechanical data side.)

HISTORY: About 10 yrs. ago — in college wore glasses for study. — Patient says eyes feel strained — moving picture shows disturb — Cannot read newspaper except at close points — No headaches — No soreness Eyes get blood-shot after reading.— No diplopia — No trouble ears, nose, etc. Has nervous indigestion — Under Dr. (X Y Z) care.

1 Ophthalmoscope	O.D. } No pathology O.S. } Pupil reactions O.K. — Tension normal	Blood Pressure
2 Ophthalmometer	O.D. 43 (180 mer.) — 44¼ (90th) O.S. 43.5 (180th) — 44¼ (90)	
3 Static Retinoscopy	O.D. +0.75 c̄ +0.87 ax 90 O.S. +0.25 c̄ +0.75 ax 90	
4 Dynamic Skiametry	O.D. +1.50 c̄ +0.75 ax 90 O.S. +1.00 c̄ +0.75 ax 90	
5 Objective Accommodation	Monocular O.D. 8 D O.S. 8 D	Binocular 8 D
6 Subjective Tests	O.D. +1.00 c̄ -.75 ax 180 V = 30/30 O.S. +0.75 c̄ -.75 ax 180 V = 30/30	
7 Comparison Tests V	OD = 30/30 -2 O.S. 30/30 -3	Equally good. Can add 0.25 O.U.
8 Tonicity Tests	O.D. ESO | EXO 1Δ | RH | LH ½Δ O.S.	
9 Ductions	O.D. ADD. = 8, ABD. = 8, SUPER. = 4, INFRA. = 4	O.S. ADD. = 8, ABD. = 8, SUPER. = 4, INFRA. = 4
10 Accommodative Convergence at 13 in.	7Δ base in to align images	
11 Subjective Accommodation (Concave lenses)	O.D. 7.5 to 8 D O.S. 7.5 to 8 D	
12 Reserve Fusion Convergence (13 in.)	Positive 8Δ as a maximum Negative 20Δ	
13 Glasses Previously Worn	O.D. +.75 c̄ -0.50 ax 180 O.S. +.62 ax 90	Read O.D. X O.S.

℞			Sph.	Cyl.	Axis	Prism	Base	
	Distance	O.D.	+1.12	-0.75	180	1Δ	IN	Size eye
		O.S.	+1.00	-0.75	180	1Δ	IN	
	Reading	O.D.	+1.50	-0.75	180	1½	IN	Shape
		O.S.	+1.37	-0.75	180	1½	IN	

Fig. 18.—The Routine of the Examination, with a Sample Set of Data. (Sheard.)

13. Glasses previously worn.
    Final prescription.

The foregoing indicated tests which bear a numeral before them are taken to constitute a good routine examination. These numbers also correspond to the numbers carried before the indicated tests on the record card diagrammed in Figure 18.

Figures 17 and 18 show the two sides of a form of record-card used by the writer. This card has its faults and its failings, but may help others. One side of the card carries, in large part, the mechanical data. Under the column "Remarks" may be recorded any data desired for which space is not provided on the reverse of the card. The reverse side carries the scientific data. A sample card from our files, exactly reproduced as to size (5 x 8 inches) and contents, with a sample set of data, is given.

In order to save space in the succeeding illustrative cases we shall refer to various tests by the numbers carried in this card.

Case 1. *Emmetropia, with excellent resources and coordination of functions.*

1. * * * 2. * * *
3. No error.
4. O. U. + 0.75 D. S. to cause neutralization at thirteen inches.
5. 9 diopters each eye. 10 diopters binocularly.
6. V (uncorrected) 20/20 each eye. Could not crowd on more than O. U. + 0.25 D. S. and not lower acuity decidedly.
7. * * *
8. ½ △ exophoria.
9. Adduction 24 △; abduction 7 △; superduction 3 △; infraduction 3 △.
10. 6 △ base in, showing that 12 △ were furnished through the accommodative act (assuming 18 △ as an average).
11. 10 diopters each eye.
12. Positive 24 △; negative 18 △.
13. None.

Prescription. None: simply some advice as to the care of his eyes looking toward the preservation of their efficiency.

Case 2. *Simulated myopia.* Young lady, aged 23 years. Complaints of frontal headaches, burning and itching of the eyes, photophobia and the usual train of symptoms of accommodative or other strain.

1. Retinal hyperesthesia. 2. * * *
3. O. U. — 0.50 D. S.
4. O. U. + 0.50 D. S. for neutralization and + 1.25 for reversal.
5. 7 D. each eye. About 8 D. binocularly.
6. V uncorrected, each eye, 7/10. With O. U. — 0.25 D. S. the acuity was apparently normal. With O. U. + 0.50 D. S. the acuity was about the same as with the naked eyes.
7. * * * 8. 2 △ esophoria.
9. O. D. Adduction 25 △; abduction 4 △; infraduction 3 △; superduction 3 △. O. S. practically the same.
10. 3 △ base out, showing that more than sufficient accommodative innervation was involved in the act of accommodating the requisite amount for the thirteen inch reading point.
11. 7 D. without correction.
12. Positive reserve 30 △; negative 10 △.

Prescription. O. U. + 0.50 D. S. to be worn initially for all close work and to be tolerated for constant wear as much as possible. After a few weeks' time practically normal acuity ensued.

Case 3. *Average condition of hyperopia with asthenopia.* V. C. H. Aged 18 years. Complaints of eyes drawing; burning sensations; eyelids and eyeballs feel dry; some pain around the orbits; distant vision said to be O. K.; no blurring of type at close points, but cannot read very long at a time without pains developing; no diplopia; eyes very sensitive to light, etc., etc.

1. Everything apparently O. K.
2. O. D. 44 (180 meridian), 44½ (90 meridian). O. S. 44 (180), 44½ (90).
3. O. D. + 0.87 D. S.; O. S. + 0.50 D. S.
4. O. U. + 1.50 D. S.
5. 7 D. each eye.
6. O. D. + 1.00 D. S. and O S. + 0.75 D. S. Visual acuity equally good and binocularly 20/20.
7. * * *
8. 1 △ esophoria.
9. * * *
10. 8 D. each eye.
11. 5 △ base in to align the images; hence accommodative convergence is 13 △ practically. This is a standard condition, according to our belief.
12. Positive 20 △; negative 12 △.

13. None.

Prescription. O. D. + 1.00 D. S.; O. S. + 0.75 D. S.

Case 4. *Low accommodative amplitude; low abduction; low negative fusion reserve.* Mr. C. C. H. 29 years of age. Wearing glasses for six years. Eyes are tired after a day's work. Cannot read at night with ease and comfort. Has frontal and superorbital headaches and pains, and so forth.

1. Everything O. K.
2. O. D. 43 (180), 43¾ (90). O. S. 43 (180), 43¾ (90).
3. O. U. + 1.75 ⊃ + 0.25 ax. 90.
4. O. U. + 3.00 to + 3.25 combined with cylinders.
5. With static findings, 5 D.
6. V (uncorrected) 20/24. With O. U. + 1.75 D. S. ⊃ — 0.37 ax. 180 V = 20/20.
7. * * *
8. No errors, wearing static findings.
9. Abduction 3 △; adduction 26 △.
10. 3 △ base out, wearing static findings; showing that there is considerable overconvergence accompanying the act of accommodation.
11. 6 D. as the limit.
12. Positive 25 △; negative 8 △.
13. O. U. + 1.00 ⊃ + 0.25 cyl. ax. 90.

Prescription. O. U. + 2.00 D. S. ⊃ — 0.37 ax. 180 for general wear; for night reading and other confining work O. U. + 2.50 ⊃ — 0.37 ax. 180.

Case 5. *Hypercropia with high esophoria or latent squint.* R. L. S. Aged 26 years. Distance vision reported good and no trouble of any character. Eyes itch and burn, chiefly left eye. Some frontal headaches; eyes fatigue under close work. Says "he feels as though his eyes let go and quit." Does not complain of diplopia.

1. * * * 2. About half a diopter against the rule, or inverse astigmatism.
3. O. D. + 1.00 ⊃ — 0.37 ax. 90; O. S. + 1.25 ⊃ — 0.50 ax. 90.
4. O. U. + 2.50 D. S. combined with cylinders.
5. 7 D. monocularly: 8 D. binocularly.
6. O. D. + 1.00 ⊃ — 0.37 ax. 90; O. S. + 1.00 ⊃ — 0.50 ax. 90: V = 30/30.
8. Maddox rod test showed 14 △ esophoria: prisms (8 △ base up or down before one eye) 10 △ esophoria. No vertical imbalance.

9. Abduction 2 △, adduction 30 △ as per record made. Probability is, however, that the abduction, taking into account the esophoric condition, should be recorded as 10 △. However, the *reserve* abduction is 2 △ only.
10. 6 △ base out; hence the esophoric condition follows through from distance to close tests and there is evidence of full convergence through the accommodative act.
11. Relative accommodation at thirteen inches: positive 5 D., negative 2 D.
12. Positive 30 △; negative 8 △ only.
13. None.

Prescription. Gave O. U. + 1.25 D. S. ⌢ — 0.37 ax. 90 ⌢ 1 △ base out for general wear. These proved satisfactory for a time: they were then increased to + 1.75 D. S. ⌢ — 0.37 ax. 90; prism exercises were given and Thorington's recommended exercise of drawing the finger from the nose to the temporal side of the face engaged in.

Remark. Eyes redressed out under cover test about 2 mms.

Case 6. *Hyperopia with low adduction power and insufficient positive reserve fusion at close points.* Mrs. M. C. B. Aged 25 years. Eyes reported under strain. Cannot read newspaper except at very close points. (The reason for this will be found in the data which follow, for binocular single vision was possible but very uncomfortable, hence such vision was suppressed at times; tests showed that the left eye assumed the diverging squint.) No complaints of diplopia. Is suffering from nervous indigestion.

1. Everything satisfactory.
2. O. D. 43 (180), 44½ (90); O. S. 43½ (180), 44¼ (90).
3. O. D. + 0.75 ⌢ + 1.00 ax. 90, O. S. + 0.25 ⌢ + 0.75 ax. 90. Examination under cycloplegics gave same cylinders with spheres augmented by O. U. + 0.75.
4. O. D. + 1.50 ⌢ + 0.75 ax. 90; O. S. + 1.00 ⌢ + 0.75 ax. 90.
5. Monocular 8 D. Binocular 7 D. (Note the lower binocular amplitude).
6. V (uncorrected) 30/40. O. D. + 0.25 ⌢ + 0.75 ax. 90 and O. S. + 0.75 cyl. ax. 90 gave V = 30/30 each eye. Could be increased binocularly by O. U. + 0.25 D. S.
7. * * *. 8. 2 △ exophoria with correction.
9. Abduction 8 △; Adduction 6 △; Superduction 4 △; Infraduction 4 △.
10. 8 △ base in to align images; hence this measures the lack of

complete convergence through accommodation. This 8 Δ must be supplied through the fusion.

11. About 8 D. each eye.
12. Positive 8 Δ; Negative 20 Δ.
13. O. D. + 0.25 $\supset$ + 0.50 ax. 90; O. S. + 0.75 ax. 90.

Prescription: O. D. + 1.12 $\supset$ — 0.75 ax. 180 $\supset$ ½ Δ in: O. S. + 1.00 $\supset$ — 0.75 ax. 180 $\supset$ ½ Δ in. For general wear and for all periods of close work the following: O. D. + 1.50 $\supset$ — 0.75 ax. 180 $\supset$ 1.5 Δ base in and O. S. + 1.37 $\supset$ — 0.75 ax. 180 $\supset$ 1.5 Δ base in.

Comments. The low fusion reserve of 8 Δ, with the demand of as much or more fusion convergence in the act of binocular single vision, shows why reading was uncomfortable at close points. Binocular single vision was maintained with difficulty. By approaching the newspaper, etc., closer to the eyes, dissociation occurred and all fusion strain was relieved and vision was monocular. This was demonstrated to be so by the discovery of divergent squint, assumed by the left eye, on approach of the ophthalmoscopic lamp toward the eyes.

Case 7. *Unequal accommodation.* E. H. Aged 19 years. Objects blurred at both distance and near points. Temporal headaches. Right eye bothers chiefly: he says that the vision in this eye is very badly blurred in close work. Has trouble with tonsils: is under treatment for this trouble at time of examination.

This case illustrates: (1) The wide difference between the static and dynamic skiametric findings; the reason is to be found in the subnormal accommodation of the right eye: (2) wide difference in accommodative amplitudes of the eyes: (3) no extra-ocular abnormalities or derangements of the functions of convergence, either accommodatively or fusionally.

1. * * *. 2. * * *.
3. O. U. + 0.75 D. S.
4. O. D. + 2.75 D. S. $\supset$ + 0.25 ax. 90; O. S. + 2.25 D. S. $\supset$ + 0.25 ax. 90.
5. With static findings, O. D. 4 diopters, O. S. 9 diopters. The pupil in the right eye very large; sluggish in response; responds to light stimulus but immediately relaxes; pupil contracts on convergence; consensual reactions satisfactory. Binocularly, the eyes work together up to about 6 inches, indicating a binocular accommodation of 7 diopters. This indicates that the innervation to the left eye is simultaneously operative in the right eye. Patient complained of seeing double when the test object was about 4 inches

from the face. This was due to the accommodative changes and not to fusion insufficiencies.

6. O. U. + 1.00 ⌒ − 0.25 ax. 180; V = 20/20.
7. Equally good when corrected. V (uncorrected), O. D. 20/24, O. S. 20/20.
8. 1 △ esophoria with correcting lenses.
9. Abduction 5 △; adduction 15 △.
10. 3 △ base in, hence 3 △ of fusion convergence demanded for binocular single vision at 13 inches. This is as we believe it should be.
11. O. D. (with No. 2 Jaeger) and wearing distance correction, 6 D., O. S. 8.5 D. Punctum proximum O. D. 7 inches, O. S. 5 inches.
12. Positive 16 △; negative 14 △.
13. None.

Prescription. O. D. + 1.75 ⌒ − 0.25 ax. 180 and O. S. + 1.25 ⌒ − 0.25 ax. 180 for constant wear. Six months later tests showed that the accommodative amplitudes were more nearly equal.

Case 8. *Dynamic skiametric less than the static skiametric findings.*

1. * * *. 2. O. D. 44 (165), 45 (75): O. S. 44 (120), 45 (30).
3. O. D. + 5.00 ⌒ + 0.37 ax. 135 and O. S. + 4.50 ⌒ + 0.50 ax. 150.
4. O. D. + 3.50 ⌒ + 0.50 ax. 135 and O. S. + 3.50 ⌒ + 0.50 ax. 120.
5. * * *.
6. V (without corrections) 20/24 — 2, each eye. O. D. + 3.75 D. S. and O. S. + 4.00 D. S. gave practically standard vision.
8. Without correcting lenses, 7 △ *esophoria.* With subjective findings 1 △ *exophoria.* With static skiametric findings 4 △ *exophoria.*
9. Without corrections, abduction 4 △, adduction 28 △. with corrections, abduction 9 △, adduction 28 △ to 30 △.
10. Without corrections, 8 △ base *out* or excessive convergence accommodatively. With O. U. + 4.00 D. S. the images were aligned, indicating full convergence associated with the accommodative act. With O. U. + 5.00 D. S. (the dynamic skiametric findings as to spherical elements) there was needed a 3 △ prism, base *in* to align images.
11. With static findings, each eye, about 4 diopters. Hence the accommodative amplitude is low due to abuse of the eyes.

12. Positive 30 △; negative 15 △.
13. None.

Prescription. O. U. + 4.00 D. S. to be worn constantly. The above corrections relieved all the main troubles and difficulties. These glasses have not been changed for three years and a few tests, quickly made, within a few months show ample resources of accommodation, etc.

Case 9. *Anisometropia with full data on the accommodative resources.* Severe frontal headaches, more so over the right eye. These come on from close work. Eyes fatigue easily. No blurring of type. No diplopia. Has 20/20 with glasses. Dissimilarity of eyes has existed for years.

1. Everything O. K.
2. O. D. 43 (180), 44½ (90): O. S. 43¼ (180), 44 (90).
3. O. D. + 0.75 D. S. $\bigcirc$ + 1.00 ax. 75; O. S. — 2.50 D. S. $\bigcirc$ + 0.37 ax. 180.
4. * * *.
5. *Corrected* with static findings, O. D. 10 D., O. S. 11 D.; *uncorrected*, O. D. 1 D., O. S. 11 D. Hence, without glasses, the left eye does all the close work.
6. O. D. + 1.50 $\bigcirc$ — 1.00 ax. 165, V = 20/20; O. S. — 2.12 $\bigcirc$ — 0.37 ax. 90, V = 20/20.
8. With corrections on, 2 △ exophoria; without corrections, 7 △ exophoria.
10. With corrections, 14 △ base in.
11. 9 to 10 diopters in each eye.
12. Positive 36 △; negative 18 △.
13. O. D. + 1.00 ax. 165; O. S., — 3.00 $\bigcirc$ — 1.00 ax. 90.

Prescription. O. D. + 1.62 $\bigcirc$ — 1.00 ax. 165; O. S. — 2.12 $\bigcirc$ — 0.37 ax. 90.

Comment. While the deficiency of convergence through the accommodative channels is marked, the fusion reserve is ample and there is no tax upon the eyes from this standpoint. The interesting features of this case are the data upon the accommodative actions of the eyes when uncorrected and corrected.

Case 10. *Paresis of convergence and insufficiency of accommodation.* J. W. Aged 27 years. Some frontal headaches; has been disturbed for some time in reading. Reports no diplopia. Has suffered from nervous derangements for some time.

1. * * *. 2. * * *.

3. O. D. + 0.62 D. S. ⊃ + 1.12 ax. 90; O. S. + 0.62 D. S. ⊃ + 1.50 ax. 90.
4. O. D. + 0.50 D. S. ⊃ + 1.25 ax. 90; O. S. + 0.50 D. S. ⊃ + 1.50 ax. 90. Note the fact that the dynamic findings are, if anything, slightly less than the static skiametric findings.
5. Monocularly about 4 diopters each eye. Binocularly, not over 2.5 diopters. At a closer point the patient experiences diplopia.
6. O. D. + 0.75 ⊃ + 1.25 ax. 90; O. S. + 0.75 ⊃ + 1.50 ax. 90.
8. 6 △ exophoria.
9. Abduction 20 △, adduction Nil, superduction 1 △, infraduction 1 △.
10. 20 △ base in. Calling 18 △ the correct amount and allowing for the 6 △ of exophoria at distance, he has an accommodative convergence of about 4 △, or practically negligible.
11. 5 diopters monocularly as the limit.
12. Positive, about 10 △ as a maximum; negative 25 △. Eyes redress in about 2 mms. under cover test.

Prescription. O. D. + 0.75 ⊃ + 1.25 ax. 90 ⊃ 1.5 △ base in; O. S. + 0.75 ⊃ + 1.50 ax. 90 ⊃ 1.5 △ base in.

Comment. The vital points in this case are the (1) absence of adductive power at distance, (2) very low positive fusion reserve and (3) depleted amplitudes of accommodation: in a word, *paresis* of ocular functions.

Case 11. *Dynamic skiametry as a monocular test only.* Mrs. B. C. T. Aged 32 years. Omitting the history and the major portion of the data, let it be stated that this case exhibited a condition of exotropia or divergent squint.

1. * * *. 2. * * *.
3. O. U. + 1.25 ⊃ + 0.50 ax. 90.
4. O. U. + 1.50 to + 1.75 combined with cylinders.
5. 5 diopters each eye. No binocular test possible.
6. O. U. + 0.75 ⊃ + 0.50 ax. 90: V = 30/30 each eye.
8. 35 △ exophoria.
10. 14 △ to 18 △ base in. When we consider that there were about 30 △ to 35 △ of exophoria at distance, we have evidence that the convergence associated with the accommodation is about 30 △ or *much more* than is normally associated with such an act. Hence the exotropia, per se, cannot be attributed to either lack of equal acuities in the two eyes or to lack of convergence as associated with accommodation in close work.
11. About 5 diopters in each eye.

12. Nil. Divergent squint.

Prescription. O. U. + 0.75 ⌒ + 0.50 ax. 90, with instructions to use each eye singly for definite periods each day. Stereoscopic exercises and other methods of fusion development were indulged in; this case could be watched and furnished excellent material for study.

Case 12. *Insufficient accommodation (weakness of the ciliary) in myopia.* Mrs. M. W. Aged 24 years. Cannot see at distance. Reads very close to face she says. Had diphtheria and scarlet fever when 10 years of age and vision has never been good since. Eyeballs get sore.

1. Pupillary responses O. K. Vitreous cloudy in each eye. Tension O. K. Papillæ, etc., O. K.
3. — 4.25 D. S.
4. — 2.50 D. S., with observation and fixation at thirteen inches.
6. O. U. — 4.50 D. S. V = 8/10. No improvement binocularly. With O. U. — 3.50 D. S., V = 6/10.
8. Without corrections, no errors. With O. U. — 4.50 D. S. 3 △ esophoria.
10. Without corrections, patient holding test-object ten inches from the face, the images were in a row. Since the patient, not wearing corrections, does not have to accommodate, (since the far-point is practically at ten inches), we must conclude that *habit* enables these eyes, while thus dissociated, to converge as if engaged in the act of binocular vision. It is to be admitted that this statement is open to criticism, however. But, with O. U. — 3 D. S. before the eyes, 6 △ base *out* were required to align the images and with O. U. — 4.25 D. S. 10 △ base *out* were needed in order to accomplish this alignment. All of these facts show that when the accommodation was made active there was associated therewith a convergence, resulting in a condition of overconvergence.
11. With O. U. — 2.75 D. S., about 4 diopters each eye.
12. Positive 25 △; negative 15 △.

Prescription. After a thorough systemic examination this case was fitted with bifocals as follows: Distance, O. U. — 3.50 D. S.; reading O. U. — 1.50 D. S., (i. e., O. U. + 2.00 D. S. added).

The chief features of interest in this case are the low amplitudes of accommodation, in a condition of myopia, evidently due to weakness of the ciliary through disuse and the evidence presented that the full burden of binocular single vision was carried by the fusion centers and that, when the accommodation was stimulated, overconvergence was thereby produced. The re-education of the ocular functions must be undertaken in such cases as this and this requires time.—(C. S.)

Skiascope. Skiascopic mirror. Retinoscope. An instrument for performing skiascopy. A number of these instruments will be found depicted and described under various headings in this *Encyclopedia*, notably under **Skiascopy**; and under **Examination of the eye**, p. 4723, Vol. VI. A few others are pictured or mentioned here.

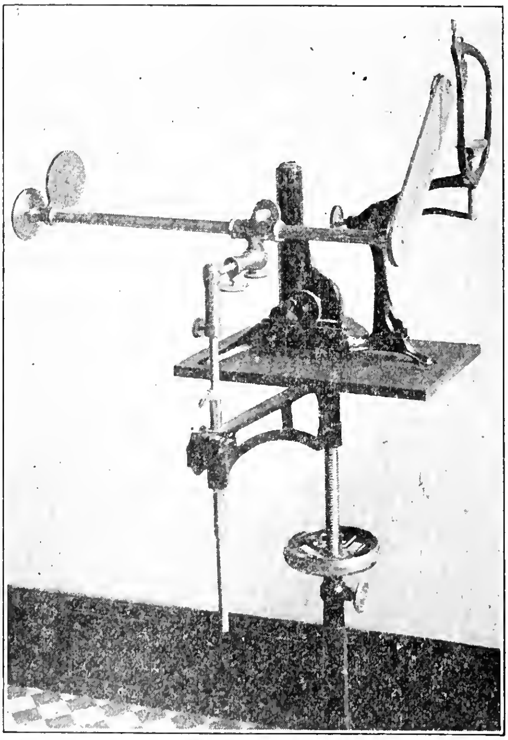
Clinton T. Cooke (*Ophthalmology*, p. 145, Jan., 1910) referring to the disadvantages of other skiascopes has sought to overcome some of the objections by using the principle of Morton's ophthalmoscope rather than a disc. This allows of the use of a two centimeter or even of an inch lens and of rapidity of change of the lenses. The lenses being protected from dust and from fogging from the patient's breath, which is troublesome in the use of Skeel's, Würdemann's or Meyrowitz's devices, require to be wiped only once in a week or two, and then being of a size which admits of access to the lenses without taking the case apart, the cleaning process is quickly completed.

The writer's skiascope contains twenty-six lenses supplemented by a disc containing two more of the trial case. The lenses range from plane to + 5.50 D. by eighths to + 1.50 D. and by quarters to + 5.50 D. The supplementary lenses are + 5.50 and — 5.50 D.

These lenses are mounted at the end of a hollow arm 62.5 cm. long, containing the shaft of the sprocket actuating the movement of the lenses. Geared to the end of the arm nearest the operator is an indicator which shows only the number of the lens through which the patient is looking. This arm, which is supported by a square cross arm permitting horizontal adjustment (for either eye), can be turned on its long axis, being held in any desired position by a squeeze collar. The whole being vertically adjustable on the base permits the writer to do more exact skiascopy than he had previously been able to do because of the power to move rapidly back and forward, without changing the position of the patient or altering the direction of his gaze, from a stronger to a weaker lens.

For example, supposing the patient to require for reversal in the horizontal meridian a + 1.50 sphere, then by turning alternately to + 1.37 and + 1.63 it is possible to tell more exactly which of the three is the lens to record. If now, without change of direction of gaze or distance of examiner the vertical meridian is found to be say + 1.25 by alternating rapidly from 1.37 to + 1.12 the astigmatic record is more likely to be exact than if the examiner had to remove the + 1.50 lenses, place them in the trial case, take out the + 1.63 lenses, wipe them, place them in the trial frame, seat himself, measure his distance, straighten the patient's head, get his gaze properly directed, compare with previous lenses,

repeat this for + 1.37, repeat for + 1.25, rise, remove, replace, wipe new lens, adjust lens, adjust head, direct gaze for + 1.37 again, and ditto all this for + 1.12. In the example given, if the card were four meters in front of the patient, the lens to be shown on the indicator would be + 0.75 for the horizontal meridian and zero for the vertical. The unspeakable drudgery of all this with a restless, stupid or hostile patient has caused many men to neglect this most accurate of the objective methods.



Cooke's Skiascope. Lateral view.

A final feature is shown in the cut, namely, a stenopaic slit, adjustable to all meridians, mounted in the disc so that subjective confirmation may be made at any time by turning back the indicator one diopter, plus the correcting glass required by the distance of the test from the patient, and requiring the patient to read the smallest line of the card.

J. F. Crouch and C. A. Clapp (*Am. Journ. of Ophthalm.*, Feb., 1914) have improved on the Würdemann skiascope in handles since

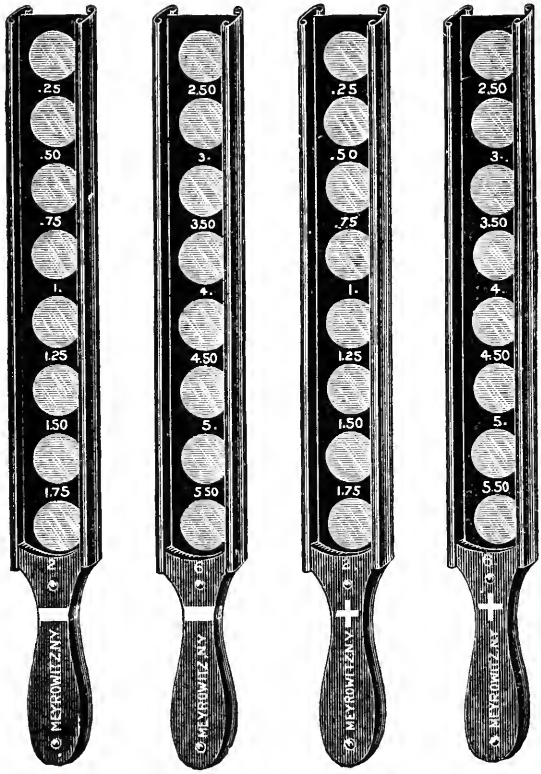
the dioptric spacing between his twenty-six lenses seems too large after 1.50, and, further, that the instrument is cumbrous, the authors have arranged a greater number of lenses in a number of hard rubber frames. Each frame contains sixteen lenses, set in two rows of eight each.

Gruening's set of hand skiascopes is designed to be held by the patient before the eye during retinoscopic examination. They each

Cooke's Skiascope. Front view.

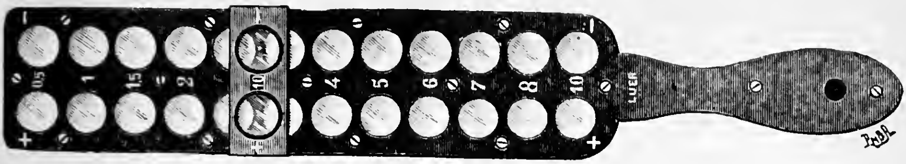
contain 8 lenses, 1½ inch in diameter, ranging from .25 to 2. D. and from 2.50 to 6 D., plus and minus, respectively. To easily select them in the dark room, the handles are conspicuously marked with white signs. The projecting rails on the sides prevent the lenses from being soiled by contact with the eyebrows or face. See the figure.

Parent's skiascope contains 24 plus and 24 minus lenses ranging from a half to ten diopters with a superimposed 10 D. lens that further increases the utility of this hand instrument. See the figure.



Gruening's Set of Hand Skiascopes.

Skiascope of Hess.



Parent's Skiascope.

Roth's Skiascope.

Skiascope of Roth. This is a combination skiascope and optometer. The ribbon attached to the rosette of lenses is rolled up when not needed.

Visser (*Klin. Monatsbl. f. Augenheilk.*, Nov., 1912), has devised a spectacle frame with reversible nosepiece, so that plus lenses can be used on one side and minus on the other. The lenses are already in the frame and the various strengths arranged by means of short rods which introduce or withdraw the lenses in front of the eye under examination. The apparatus in its simplest form was devised for oculists who determine the point of reversal largely by changing their distance from the patient.

Wolff (*Zeitschr. für Augenheilk.*, July, 1914) describes a method of *performing retinoscopy with a Nernst lamp* provided with a slit which can be rotated into any desired meridian and a plate of plain unsilvered glass, and criticizes Gullstrand's method of performing the same operation. But why, Harrison Butler pertinently asks, use an expensive piece of apparatus for retinoscopy when a competent man can get perfect results with any small electric bulb or even with a bedroom candle?

Skiascopy. Retinoscopy. Photoscopy. Kraspedoscopy. Fundus-reflex test. Anephotoscopy (blanco). Pupilloscopy. Keratoscopy. Coroscopy. Sciascopy. Umbrascopy. Dioptroscopy. Shadow-test. Scotoscopy. Phantoscopy. Retinophotoscopy. Koroscopy (landolt). Retinoskiascopy. Skiametry. A method of measuring the refraction of the eye by observing if the apparent movement of light and shadow in the pupil indicates an erect or an inverted image, and whether the form of the areas of light and shadow in the pupil indicate the presence or absence of regular or irregular astigmatism. In 1862 Bowman (*Royal London Ophthalmic Hospital Reports,* Vol. II, p. 157), called attention to appearances characteristic of irregular astigmatism and conical cornea, and Donders in 1864 (*Accommodation and Refraction of the Eye,* p. 490) wrote "My friend Bowman recently informs me that 'he has been sometimes led to the discovery of regular astigmatism of the cornea, and the direction of the chief meridians, by using the mirror of the ophthalmoscope much in the same way as for slight degrees of conical cornea.' "

The use of the ophthalmoscope above referred to, for the detection of irregular astigmatism, became widely popular. It was generally adopted as the most satisfactory test for this kind of defect. But the observation that the same method was capable of revealing regular astigmatism and the direction of its principal meridians, does not seem to have attracted general attention.

In 1872, Couper, in his paper before the Fourth International Ophthalmological Congress (see *Trans.* page 109), alluded to Bowman's observations, and said: "The greater dispersion in one meridian than in the opposite, gives rise to the linear shadows. Only the fact of astigmatism is thus established."

In 1873, Cuignet, of Lille, published (*Rec. d'Ophtalmol.*, 1873, pp. 14 and 316) an account of the test with the plane mirror as giving a practical method of measuring the amount of these errors of refraction. He seems not to have appreciated fully the optical principles involved in the test, and his account of it attracted no attention. But, in 1878, his pupil, Mengin, introduced the practice of the method at Galezowski's clinic in Paris. There it was taken up, and Parent demonstrated its true optical basis and urged its advantages in a series of articles published in the *Recueil d'Ophtalmologie* in 1880-81, pp. 65 and 229.

Lytton Forbes, (*Royal London Ophthalmic Hospital Reports* for 1880, p. 62), published a minute account of the various forms assumed by the light and shadow in the pupil. In 1881, A. Stanford Morton included a full description of the test in his little work on the *Refraction of the Eye*. In 1882, Charnley gave the fullest demonstration of its optical basis (*Royal London Ophthalmic Hospital Reports,* X, 3, p. 344); and Juler called attention to it in the *Ophthalmic Review,* Vol. I, p. 327.

Those who followed Parent had used the concave mirror. Cuignet had used the plane mirror, and, in 1882, Chibret pointed out (*Annales d'Oculistique*, Vol. XXXVIII, p. 238) the advantages of the plane mirror in determining the presence and degree of myopia in the examination of large numbers of recruits. Story (*Ophthalmic Review,* Vol. II, page 228) advocated the use of the plane mirror, at a distance of four metres from the patient.

In 1885, (*American Journal of the Medical Sciences,* April, p. 404) the writer described the test with the plane mirror, the determination being made by measuring the variable distance of the surgeon from the patient. Later he discussed the retinal illumination (*Ophthalmic Review*, Feb., 1890) and the relative positions of the source of light and the observer (*Archives of Ophthalmology*, July, 1893); and in 1905 (*Skiascopy and Its Practical Application*, 3rd ed. p. 97) the method of measuring objectively the power of accommodation. Later this use was expanded by Cross and given the name of dynamic skiametry. Sheard discusses it in his *Dynamic Ocular Tests*, Chap. VII.

Name of the test.—Neither Bowman nor others who early employed

the test proposed for it any special name. Cuignet called it *kerato-scopie.*

Parent proposed retinoscopie, in allusion to the fact that it was the movement of light and shade on the pigment layer of the retina that gave rise to the phenomena studied.

Chibret, to bring out the point that it was the movement of a shadow that was the subject of investigation, proposed the name of fantoscopie retinienne, and Priestly Smith called it the shadow-test. This name became extremely popular, and its appropriateness led Chibret to call to his aid the linguistic skill of M. Egger, who rendered it in the term skiascopia, which in its French form skiascopie, or its English form, skiascopy, has been most widely accepted as the proper term to designate the test.

Umbrascopy was proposed by Hartridge, and by Landolt, pupilloscopie, and afterwards the equivalent, koroscopie. Dioptroscopie was advocated by Galezowski *(Atlas d'Ophtalmoscopie)* and its appropriate, though equally applicable to other methods of measuring refraction.

Retinophotoscopie and retinoskiascopie suggested by Parent, and fundus-reflex test suggested by Oliver, are unnecessarily long for a name.

Stevenson chose to call it *photoscopy,* claiming it was the movement of light that was watched upon the dark background of the pupil; and Schoen proposed *kraspedoscopy* (from κραπδεον, the margin), as the subject of observation is really the margin between light and shadow.

The general optical principles involved have been discussed (Vol. XIII, p. 9916, of this *Encyclopedia*), and by many writers in ophthalmologic journals. Among the latter one of particular interest is that of Landolt (*Archives d'Ophtalmologie,* Vol. 35, p. 1). That of Burnett (*American Journal of Ophthalmology,* Vol. XX, p. 145 and 161) is also especially clear. Skiascopy is a method of measuring myopia, either the myopia originally present in the eye or that produced by a lens of known strength in the process of measurement. In myopia, rays of a certain divergence, that is, coming from a point a certain finite distance in front of the eye, are brought to a focus upon the retina. Conversely, the rays coming from a point of the retina and passing out through the crystalline lens and cornea, are brought to a focus somewhere in front of the eye. The point for which the eye is focused, and the point on the retina, on which the focused rays are received, have to the refractive surfaces of the eye the relation of *conjugate foci.*

The reversal of movement.—The amount of myopia is known when we know the distance of the point in front of the eye, which has this relation of a focus conjugate to the retina. Skiascopy furnishes a method of determining the position of this point. Closer to the eye, than this point for which it is focused, the observer may see an erect image of the fundus. Farther from the eye than this point, he can perceive an inverted image. Skiascopy is a means of determining when the image seen is erect and when it is inverted, or when it passes from the erect to the inverted.

When this occurs may be understood from a study of figure 1, Let M represent a myopic eye, A and B being two points of the retina from which rays emerge to reach the observer's eye; and C and D the points at which these rays coming from the retina are focused, the rays coming from A being focused at C and those from B at D.

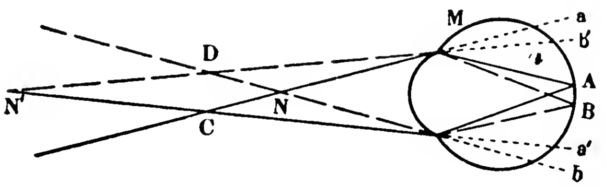


FIG. I.

Skiascopy.

Rays Emerging from the Eye Showing the Reverse of the Image.

The apparent position of a point is determined by the direction of a ray coming from that point, and passing through the nodal point of the observer's eye. Suppose the observer's eye is placed at N, closer than the point for which the observed eye is focused. The apparent position of the point A is determined by a ray which passes through the upper part of the pupil and is turned down. It appears in the direction of a. The apparent position of the point B will be located by the ray coming through the lower part of the pupil and turned up. It will be seen in the direction of b. Thus, from this position N, the point, A which is really above appears above, and the point B, which is really below appears below. The observer sees an erect image.

When, however, the observer places his eye at N′, at a greater distance than that for which the eye is focused, the ray which reaches his nodal point from A, will be one that comes through the lower part of the pupil and is turned up; so that A will appear to be located in the direction of a′ in the lower part of the pupil. From this position

he will judge the location of B by the ray which comes through the upper part of the pupil and is turned down, so that B will appear to be located in the direction of b′ in the upper part of the pupil. That is, the point A, which is really above, will appear to be below, and the point B, which is really below will appear to be above. The image observed is inverted.

The point of reversal.—It is evident that this change in the relation of the rays, that brings about the change in the apparent position of A and B, occurs at the distance of the points C and D, at which the rays coming from the retina are focused. Here it is that these rays intersect and take their new relation which gives the reversal of the apparent position of the points of the retina from which they come. It is, therefore, convenient in connection with skiascopy to designate this point as the point of reversal. Of course, it is really the same point as the far point of the myopic eye—the point for which the eye is focused—the conjugate focus of the retina. The distance of the point of reversal from the eye, being the distance from the eye to its far point, is the focal distance of the lens required to correct the myopia.

It is only when the rays leave the eye convergent, only when the eye is myopic, that they come to a focus in front of it. If the eye be emmetropic or hyperopic, the rays emerging parallel or divergent remain so at all distances. Hence, in emmetropia and hyperopia, there can be no point of reversal. From whatever distance the eye is viewed, the image perceived is erect.

Skiascopy determines the position of the point of reversal by observation of the directions of the movement of light and shade in the pupil. Other kinds of ophthalmoscopic examinations attempt the recognition of the details of the fundus image. But, as the point of reversal is approached, the details of the fundus image become indistinct and fade away entirely, so that the location of the point of reversal cannot be accurately determined by such an examination. On the other hand, when this point has been so closely approached that the fundus details are quite indistinguishable, it still remains easy to recognize the direction of the movement of light and shade in the pupil; and, from it, to deduce the erect or reversed character of the image. Skiascopy, therefore, determines the point of reversal, and measures the degree of myopia with much greater exactness than the fundus image test.

The light area.—In skiascopy, we watch the apparent movement of light and shade in the pupil, due to the real movement of an area of light upon the retina. This area of light is secured by reflecting

into the eye the light from a lamp with a skiascopic mirror. This is done in a darkened room, in order that the retina outside of this light area may be dark, furnishing a decided contrast to the area to be watched. The movement of the light area upon the darkened retina is secured by rotating it about some axis lying in the plane of the mirror and passing through the sight hole. The direction of the real movements thus produced by a certain rotation of the mirror depends on whether it is plane or concave.

Sources of light.—The lamp flame, or similar source of light used for the test, may be called the original source of light, in contradistinction to the reflection of it from the mirror, which being more immediately related to the movement of the light on the retina, we shall call the immediate source of light. With the *plane mirror* the immediate source of light is behind the mirror as far as the original

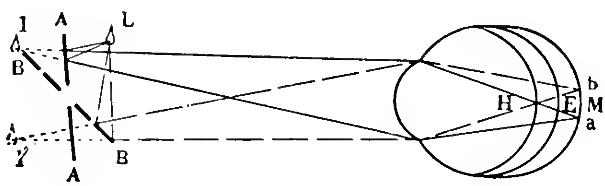


FIG. 2.

Skiascopy.
Movement of Immediate Source and Light on Retina with Plane Mirror.

source of light is in front of it. The rays reflected from the mirror enter the eye under observation as though they had started from this immediate source. As the mirror is rotated, the apparent position of the immediate source of light changes; for this immediate source is situated upon a line drawn through the original source perpendicular to the surface of the mirror, and necessarily changes with that perpendicular as the inclination of the mirror changes.

With the change of position of the immediate source of light, the rays coming from it and falling upon the eye, are made to fall upon a new part of retina, and thus the inclination of the mirror causes a change in the part of the retina that is lit up by the light reflected into the eye.

What these changes are can be better understood by a study of figure 2. L represents the position of the lamp flame, the original source of light. When the mirror is held in the position AA, the immediate source of light is situated at 1, and light entering the eye from that direction falls upon the retina toward a. When, however, the

position of the mirror is changed to BB, the immediate source of light is changed to 1′, from which light falls upon the retina toward b. As the mirror is rotated from AA to BB, the position of the immediate source of light moves from l to l′, and, as a consequence, the area of light upon the retina moves from a to b. The light on the retina, then, moves in the direction that the mirror is made to face. It is said to move with the mirror.

Only a portion of the light reflected by the mirror enters the eye, the remainder falls upon the face and makes an area of light on the face. One may readily demonstrate by trial that this area of light cast by the mirror on the face also moves with the mirror under all circumstances.

The rays of light coming from l and l′ intersect at the nodal point of the eye; and passing directly on do not again change their relative positions. Whatever the distance of the retina from this nodal point, the movement of the light upon it will be in the same direction, so that whether the retina be at H. as in hyperopia, at E. as in emmetropia, or at M. as in myopia, the real movement of light upon it from a certain movement of the mirror is always in the same direction.

Therefore, with the plane mirror, the real movement of the area of light on the retina is with the mirror—with the area of light on the face—in all states of refraction. This is true for all distances of the light from the mirror, or of the light and mirror from the tested eye.

The concave mirror. With the concave mirror as used in skiascopy, the immediate source of light is a real focus of the mirror, conjugate to the position of the light, situated between the mirror and the eye to be tested. The position of this immediate source varies with the position of the mirror, moving in the direction that the mirror is made to face and causing an opposite movement in the area of light that falls from it upon the retina.

In figure 3, L again represents the original source of light. When the mirror is in the position AA, the light falling upon it from L is focused at l., and the little inverted image of the lamp flame there formed is the *immediate source* of light. From it the rays diverge, some to fall upon the face, and those entering the eye to fall upon the retina toward a. When the mirror is turned to occupy the position BB, the light falling upon it is focused at l′, which becomes the new position of the immediate source of light, and from which the rays entering the eye fall upon the retina toward b. As the mirror is rotated from AA to BB, the immediate source of light moves from l to l′ and the light upon the retina from a to b. This will be the

direction of its movement in all states of refraction whether the retina be situated at H. as in hyperopia, at E. as in emmetropia, or at M. as in myopia. The portion of the light which falls upon the face, however, and forms the facial area, as can be readily demonstrated by trial, moves in the direction that the mirror is made to face.

We have then: With the concave mirror, the real movement of the area of light on the retina is against the mirror, and against the light on the face, in all states of refraction.

The above is the movement that occurs with the concave mirror used as in skiascopy so far from the original source of light and from the eye to be tested, that the conjugate focus of the original source of light falls in front of the eye. If, however, the original source of light be brought so close to the mirror that the rays from it are not rendered convergent, but continue to diverge after reflection, the im-

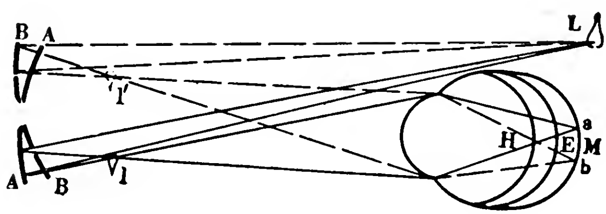


FIG. 3.

Skiascopy.
Movement of Light with Concave Mirror.

mediate source of light will be a magnified image of the lamp flame, situated behind the mirror as in the case of the plane mirror; and the movement of the retinal light area will be precisely the same as with the plane mirror. Again, if the rays reflected by the mirror are rendered convergent, but the eye to be tested is brought so near that they cannot come to a focus in front of its nodal point, the light will pass in as though from an immediate source back of the mirror, and the movement of the area of light on the retina will again be like that with the plane mirror. If the light reflected upon the eye be convergent so as to be focused just at its nodal point, no movement of light on the retina, such as we have been considering, will occur; but whatever direction the mirror is turned, so long as the light enters the eye, the retinal light area will remain stationary.

It is to be borne clearly in mind that the movement so far spoken of is the real movement of the light area upon the retina, as it could be seen from behind the retina, with the sclera and choroid cut away.

The apparent movement of the light in the pupil. What we observe in skiascopy, however, is the apparent movement of the light in the pupil as viewed from the position of the observer some distance in front of the eye. When an erect image of the retina is viewed, this apparent movement of the light will be in the same direction as the real movement. When an inverted image is viewed, the apparent movement will be in the direction opposite to that of the real movement.

The observer can always watch the movement of the light area on the face, and know that with the plane mirror the light area on the retina always has a real movement in the same direction, and with the concave mirror it always has a real movement in the opposite direction; and he has only to compare the apparent movement of the light which he watches in the pupil with the known direction of the real movement on the retina, to determine whether he sees an erect or an inverted image. When the apparent and real movements are in the same direction, he knows he is looking at the eye from a distance shorter than that for which it is focused. When the apparent and real movements are in the opposite directions, he knows that he is looking at the eye from a distance greater than that for which it is focused.

The apparent movement will be with the real movement in hyperopia and in emmetropia at all distances, and in myopia when the eye is viewed from a point nearer than its point of reversal. The apparent movement in the pupil will be the opposite of the real movement only in cases of myopia when the eye is viewed from beyond its point of reversal.

With the plane mirror, the apparent movement is with the light on the face in hyperopia, emmetropia, and myopia with the point of reversal behind the observer, and against the light on the face in myopia viewed from beyond the point of reversal.

With the concave mirror the apparent movement is against the light on the face in hyperopia, emmetropia, and myopia with the point of reversal behind the observer; and is with the light on the face only in myopia viewed from beyond the point of reversal. This statement made to conform to the practice customary in the use of the concave mirror [where the observer keeps a constant distance of 1 metre from the eye, corresponding to 1 D. of myopia], would be: the light moves against the light on the face and against the mirror in hyperopia, emmetropia, and myopia of less than 1 D., and only moves with the light on the face in myopia of more than 1 D.

These statements hold with reference to the apparent movement of

the light before the state of refraction has been modified by any glass placed before the eye; or as to hyperopia, emmetropia, or myopia remaining uncorrected or produced by a lens placed before the eye.

Rapidity of movement of the light on the retina. The rapidity with which the light and shadow appear to move across the pupil depends first, on the rapidity of the real movement of the light area upon the retina; and, second, upon the magnification of the retina. The rapidity of the real movement on the retina depends:

On the rate of movement of the mirror in the observer's hand. On the distance of the mirror from the observed eye. On the distance of the original source of light from the mirror. And upon the distance of the retina from the nodal point in the observed eye.

The rapidity of the real movement of the light on the retina then, is increased: By moving the mirror faster. By carrying the original source of light farther from the mirror. By bringing the mirror closer to the eye. By elongation of the antero-posterior axis of the eyeball. The real movement of the light upon the retina is made slower: By moving the mirror more slowly. By bringing the original source of light closer to the mirror. By carrying the mirror farther from the eye. By shortening of the antero-posterior axis of the eyeball.

In using the test, the distance of the light from the mirror is, for most purposes, practically constant, and the ordinary variations in the antero-posterior axis of the eyeball are so slight as to have no appreciable influence. So that the rapidity of the real movement of light on the retina depends principally on the rapidity of the movement of the mirror and the distance of the mirror from the eye.

Magnification of the retina. In practice the rapidity of the apparent movement of the light in the pupil depends far more on the extent to which the retina, and the real movement of light upon it are magnified, than upon the actual rate of that real movement. The retina, as viewed through the pupil from different distances, is seen under different degrees of magnification. When the observer's eye is placed at the point of reversal, the rays from a single point of the retina, passing through all parts of the pupil, converge to the observer's nodal point, so that the one point of the retina appears to occupy the whole of the pupil, and the retina is seen indefinitely magnified. As the observer's eye departs from the point of reversal, it receives the rays from an increasing area of the retina, more and more of the retinal image occupies the same space of the pupil and the retina is seen less magnified.

This is illustrated in figure 4, which represents an eye with its point

of reversal at A. If the observer's eye be placed at A it receives rays only from the point a, and this point appears to occupy the whole pupil. If, however, the observer's eye be placed at B, from which rays would be focused at b behind the retina, and, at which, rays from b would be focused, the observer will be able to see in the space of the pupil all of the retina, m n included, between the broken lines passing from B to b. Or, again, if the observer's eye be placed at C, from which rays will be focused at c in front of the retina, he will be able to perceive the portion of the retina, m n included, between the dotted lines, passing through c and continued on to the retina. The closer the observer's eye to the point of reversal, the more is the real movement of light upon the retina magnified, and, therefore, the swifter does it appear. The farther the observer's eye is removed from the point of reversal, the less is that real movement of light on the retina magnified; and the slower is the apparent movement as

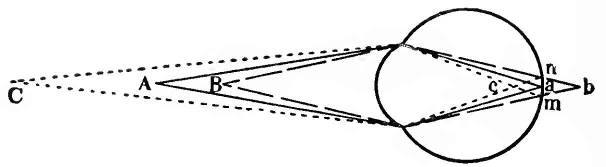


FIG. 4.

Skiascopy.

Showing Retina Seen at Point of Reversal, and Nearer or Farther from the Eye.

watched in the pupil. As this source of variation overcomes all other sources of variation in the rate of the apparent movement of the light [except the rate of rotation of the mirror, which is, to a considerable extent, under the control of the observer], the rapidity of the apparent movement of light and shade in the pupil increases as the point of reversal is approached, and diminishes as that point is departed from, and constitutes a measure of the degree of ametropia remaining uncorrected.

Form of the light area. The real form of the light area on the retina, except under certain conditions in astigmatic eyes, will be circular. If the light be perfectly focused on the retina it is usually circular, because that is the form of the source of light employed. If the light be not perfectly focused on the retina, the circular pupil gives a circular area of diffusion.

The influence of astigmatism on the apparent form of the light area as seen in the pupil will be discussed later. In eyes free from such defects the form varies with the departure of the observer's eye from

the point of reversal. If the magnification of the retina is so slight that all of the light area is visible in the pupil at once, that area appears circular, as represented in figure 5. But when the point of reversal is approached so that the magnification of the retina prevents all of the retinal light area from being seen at one time, only a portion of its outline is visible as an arc of the greatly enlarged circle, as shown in figure 6; and the nearer to the point of reversal that the observer comes, the nearer does the boundary between light and shade approach to a straight line. But it is still part of the boundary of a circle, so that different parts run in different directions, unlike the band-like appearance of astigmatism, the direction of which always conforms to one or the other of the principal meridians.

From the point of reversal, a single point of the retinal light area is visible to the observer at a time, so that the form of that area could

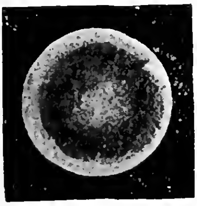


Fig. 5. Skiascopy.
Light Area. Seen From Far Point of Reversal.

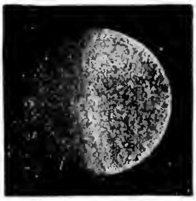


Fig. 6. Skiascopy.
Light Area. Seen from Near Point of Reversal.

not from this position influence the form of light and shade apparent in the patient's pupil. From this single luminous point of the patient's retina the light is not focused on the observer's retina, but falls there in an area of diffusion which takes its form from the pupil of the observer. For a full discussion of this matter see paper by Carl Weiland (*Medical News*, October 12th, 1895), and one by the author (*Annals of Ophthalmology and Otology*, April, 1896).

Brightness of the light in the pupil.—This depends on the illumination of the retinal light area and the extent to which that area is magnified.

The illumination of the light area on the retina depends on the brightness of the original source of light and the accuracy with which the light coming from it is focused on the retina. The brighter the source of light and the more accurately it is focused, the brighter the illumination of the retina. The dimmer the light and the larger the circle of diffusion over which it is dispersed, the more feeble the retinal illumination. When the source of light approaches the point of re-

versal, the light is more nearly focused on the retina, and the actual illumination of the light area in the patient's eye brighter.

But, as the point of reversal is approached, the apparent brightness of the light area in the pupil is diminished by the increasing magnification of the retina, which causes the light from a smaller part of the retinal area to occupy the whole space of the pupil. Again, when the observer is near the point of reversal, the part of the retina that he can see is the part to which light can be reflected only from the immediate vicinity of the sight-hole and the sight-hole itself. On this account the illumination of this part of the light area is feeble. The brightest apparent illumination of the pupil is never obtained at the point of reversal, but usually at one or two dioptres from it, the exact position being dependent on the arrangement of the source of light.

Finding the point of reversal.—The point of reversal is recognized only when the observer's eye is in its immediate neighborhood. This may be effected either by varying the distance of the observer's eye from the observed eye until it comes to the position of the point of reversal, or by varying the position of the point of reversal by changes in the lenses placed before the observed eye until the point of reversal comes to the chosen position of the observer's eye. The former method is the better when using the plane mirror, and the latter when the concave mirror is employed. The trial movement of light across the pupil shows by the direction of the movement whether a point of reversal exists between the observer and the observed eye, and the rapidity of movement shows approximately how near the observer is to the point of reversal. If the movement be slow, the interval is large, perhaps several dioptres. If it be rapid, the interval is less.

Upon the direction and rapidity of the movement, the surgeon bases the next step of the test, the selection and placing of lenses before the eye. This being done, the test is repeated, the movement seen through the lens noted, both as to its direction and rapidity, and the distance of the observer from the patient, or the strength of the lens before the observed eye, varied in accordance therewith. This process is continued until the observer's eye reaches the point of reversal, or the point of reversal is brought by the lens to the observer's eye. But the test should not be regarded as complete until the movement has been repeatedly viewed both from within and from beyond the point of reversal, as well as from that point. Only by this precaution of observing from a slightly greater and a slightly less distance, or with a slightly stronger or slightly weaker lens than that which brings the point of reversal to the surgeon's eye, can the certainty of a correct result be assured.

Darkening the room.—In skiascopy one has to observe the movement of an area of light across the shaded retina. The size, brightness and sharpness of the contrast between the margin of this light area, and the shadow immediately adjoining it are very important factors in determining the definiteness and accuracy of the test. Since the contrast between light and shadow seen in the pupil, necessarily diminishes as the point of reversal is approached, it is important to have the actual contrast between light and shadow upon the retina as sharp as possible. To increase this contrast, the retina outside of the light area should be in darkness. This requires a darkening of the room, including shading of the source of light, except in the direction in which it is used. Pannell (*Ophthalmology,* v. II, p. 770) found that skiascopy in a well darkened room tended to produce relaxation of accommodation, especially if the small light area was kept turned on the retina with as little interruption as possible. The difference in the case of the test applied in a completely darkened room, can only be appreciated by one accustomed to so applying it.

The source of light.—To secure the brilliant illumination of the light area, the source of light must be as bright as possible. Because the arc electric light would disappear in the sight hole, and because of the form of the ordinary incandescent lamp, these cannot be employed except to illuminate a piece of ground glass, this must be used or better, one of the various illuminating flames. The acetylene flame is most brilliant, but has not been much used. Next come paraffin, the heavy mineral oils, and gas flames reinforced with the richer hydro-carbons, or used on the Welsbach mantle. Whatever source is used it is more important that the brightest part of it should be employed. With all flames there is at the margin a comparatively gradual shading from light to darkness, which interferes with the sharpness of the boundary of the light area on the retina. To secure that sharp boundary as well as to prevent the diffuse illumination of the room, and to limit the size of the source of light, the flame should be entirely covered by an opaque shade with an aperture of the proper size placed opposite the most brilliant part of the flame. This gives, with proper focusing, a sharp margin to the light area on the retina.

The size of this opening in the opaque screen must be a compromise between various conflicting requirements. The smaller the source of light, the more characteristic its shape in regular astigmatism, and the easier to distinguish the different movements in different parts of the pupil in irregular astigmatism and aberration. But enough light must be furnished by it to give a distinct area of light upon the face, as well as to give sufficient illumination within the pupil; and the

source of light must be considerably larger than the sight hole in the mirror. As the mirror is rotated, the immediate source of light appears to move across it, and if this source were not larger than the sight hole, it would, at times, entirely disappear within that opening. At such times, no light would fall upon the retina and the illumination would disappear entirely from the pupil, causing delay and uncertainty in the test. If, however, the immediate source of light is larger than the sight hole, no such disappearance of the light occurs.

The size of the opening through which light is obtained, is then a compromise between the requirements of light and the size of the sight hole on the one hand, and a need to have the retinal light area as small as possible on the other. The diameter of the source of light for accurate work with the plane mirror may generally be reduced to little more than twice the diameter of the sight hole. In practice the writer prefers an aperture five millimetres in diameter, but the beginner may find one of double that diameter more satisfactory.

The sight hole.—This must be large enough to allow the observer to readily watch through it the movement of light on the face, as well as in the pupil. This will be facilitated by the thorough darkening of the room, and the complete freedom of the sight hole from reflections. With this limitation, the sight hole should be as small as possible, to reduce the area from which little or no light is reflected into the eye, and to reduce the circles of diffusion formed on the observer's retina when he watches the movement of light and shade from the immediate vicinity of the point of reversal. A sight hole two millimetres in diameter has rendered the best service.

Focusing of the light on the retina.—When the rays coming from the immediate source of light are accurately focused on the retina, the area of retinal illumination will be the smallest and brightest, and will have the most definite edge. This accurate focusing is secured only when the immediate source of light is situated at the focus conjugate to the retina—the point of reversal. *In searching for the point of reversal, it is advantageous to keep the immediate source of light as close to the observer's eye and the mirror as possible.*

With the plane mirror the immediate source of light is a reflection of the original source as far behind the mirror as the immediate source is in front of it. The closer the original source of light can be brought to the mirror, the closer will its reflection be to the observer's eye; and to the point of reversal, at the critical moment when the observer's eye reaches that point. The original source of light then should be kept as close to the mirror as possible. On this account it should be moveable, to follow the movements of the observer's eye and the mir-

ror, when the distance of these from the eye under observation is varied.

When the observer withdraws to the distance of two metres or more from the patient, it may not be practicable to keep the light very close to the mirror, but at such a distance, the separation of the source of light from the mirror represents less than a half dioptre of change in the focus and becomes of small importance.

On the other hand when the surgeon approaches close to the patient's face the slight distance that must necessarily remain between the original source of light and the mirror causes more imperfect focussion of the light on the retina, and inexactness of determining the point of reversal. It will reach the pupil 5 D. divergent when the surgeon is seeking the point of reversal corresponding to 8 D. of myopia. This difference of 3 D. interferes greatly with the delicacy of the test.

With the concave mirror, the immediate source of light being a real image of the original source in front of the mirror, at its focus conjugate to the position of the original source, cannot be brought closer to the mirror than its principal focal distance. It is brought closest by carrying the original source of light as far away from the mirror as possible. The original source of light then, for the concave mirror, should be behind the patient as far as possible.

The important exception to these rules for placing the light, necessary for the most accurate determination of the principal meridians in regular astigmation is discussed in connection with that subject.

Position of the observer for greatest accuracy.—With the plane mirror the immediate source of light is necessarily behind the mirror. It will, therefore, be exactly at the point of reversal when the mirror and the observer's eye are slightly within the point of reversal. Hence the conditions of accuracy are better complied with for the observation that is made from within the point of reversal, where the light still moves in the pupil with the light on the face, than for the observation that is made from beyond the point of reversal, where movement is inverted. The point of reversal is then, with the plane mirror, most closely approximated from the side toward the observed eye; and in practice the greatest accuracy is attained by considering that the point of reversal is located at the greatest distance from the eye at which erect movement can be seen in the visual zone of the pupil.

With the concave mirror the immediate source of light being necessarily in front of the mirror, can be brought accurately to the point of reversal only when that point of reversal is the focal distance of the mirror in front of the observer's eye. The point of reversal then

is approached more accurately with the lens which still leaves it in front of the observer's eye, than with the lens which removes it back of the observer's eye. Hence, with the concave mirror, the strongest concave lens, or the weakest convex, which allows the movement of light in the pupil with the light on the face, is the lens which brings the point of reversal most accurately to the distance chosen.

Distance of the surgeon from the patient.—It will always be impossible to determine the point of reversal with perfect exactness. The best that can be done is to make out that it lies, within narrow limits of possible error, at about a certain distance. It may be a little nearer, it may be a little farther off.

If the lens used be such that the point of reversal is brought close to the observed eye, the probable inaccuracy of distance will cause an appreciable error in estimating the refraction, measured in dioptres. For instance: at eight inches from the eye, two inches additional, making ten inches, will correspond to a whole dioptre of refraction, and two inches less, making the distance six inches, will correspond to a difference of a dioptre and a half. On the other hand, at eighty inches, a foot either way will correspond to less than one-quarter of a dioptre of inexactness. Hence, *for accurate work it is best to make the determination of the point of reversal at the greatest distance at which it can be certainly made in the visual zone.*

What this distance may be will vary in different eyes. In general, it is limited by the size of the area in which the movement of light and shade is to be watched. The pupil fully dilated may be eight or ten millimetres in diameter, but the diameter of the visual zone of the pupil, the only area in which the movement is of practical importance, is commonly much less, say from 4 to 6 millimetres; and the movement of light across it can only be satisfactorily studied within the distance of two or three metres. Beyond one metre, the necessary inaccuracies of distance become usually of slight practical importance.

In cases of aberration invading the central portions of the pupil and in cases of irregular astigmatism, the visual zone is less in area than in the ordinary normal eye. In these cases, the test must be applied from a still shorter distance, often one-half or one-third of a metre, or even less.

With the plane mirror it is easy to adopt any distance that suits the particular case. With the concave mirror any considerable variation in the distance requires a corresponding variation in the focus of the mirror used; a mirror of shorter focus being employed when the distance between the observer and patient must be short; and of

longer focus if a greater distance is to be maintained. In general the distance at which a concave mirror can be used to best advantage is a little over four times its focal distance. For the majority of cases then, a distance of from ½ to 2 metres is convenient for the plane mirror; and one metre or a little less for the concave mirror, having the usual focal distance of from 20 to 25 centimetres.

Final test.—When it is desired to make the shadow test as accurate as possible, it is well to complete the test by placing before each eye lenses representing its supposed correction, with such addition to the convex or diminution of the concave spherical as shall bring the point of reversal to the greatest distance at which the movements of light and shadow can be satisfactorily studied in the particular eyes in question; and from that distance to test the movement of light and shade, looking especially for uncorrected astigmatism, and comparing the one eye with the other for any evidence of remaining inequality of refraction.

REGULAR ASTIGMATISM IN SKIASCOPY.

The essential fact of regular astigmatism is that in two different directions, at right angles to each other [the principal meridians] the curvature of the dioptric surfaces differs, so that they exert unequal refractive power; and that in all other directions, the refractive power is such that it is corrected when these two meridians are corrected.

Two points of reversal.—Rays coming from a point of the retina, and passing out through surfaces that refract unequally in different meridians, must leave the eye with different degrees of divergence, or convergence, in the directions of these different meridians. If after passing out the rays are convergent, or are rendered so by passing through a convex spherical lens, they will be more convergent in one principal meridian than the other, and the point of reversal for one principal meridian will be nearer the eye, than the point of reversal for the other principal meridian. The position of each point of reversal gives the amount of myopia (either original or produced) in the principal meridian to which it belongs. The difference between the amounts of myopia in the two principal meridians is the amount of astigmatism. The general plan of measuring astigmatism by skiascopy is to ascertain the point of reversal and measure the degree of myopia for each principal meridian separately; and then, by subtracting the one amount from the other, to find the amount of regular astigmatism.

The band-like appearance.—This difference in the position of the points of reversal for the different meridians, gives rise to certain

phenomena of great practical importance in skiascopy. As the point of reversal is approached, the image of the retina seen through the pupil becomes magnified, it necessarily follows that when the observer's eye is nearer to the point of reversal for one meridian than it is to the point of reversal for the other meridian, the retinal image is more magnified in the direction of the principal meridian, to which the nearer point of reversal belongs.

When the observer's eye is placed at the point of reversal for one meridian, the retinal image becomes indefinitely magnified in the direction of that meridian, while comparatively little magnified in the direction at right angles to it. Each point of the retina then appears in the pupil as a line running in the direction of that principal meridian, and the retinal light area, which consists of a number of these points, takes the form of an elongated band of light, running in the direction of the principal meridian which has its point of reversal

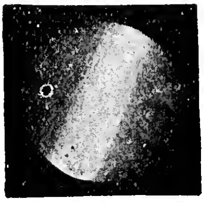


Fig. 7. Band of Light in One Principal Meridian.

Fig. 8. Band of Light in Other Principal Meridian.

at the observer's eye. This is the band-like appearance of the light in the pupil, characteristic of astigmatism. Figure 7 represents this appearance when the eye is placed at the point of reversal for one principal meridian, represented about twenty degrees from the vertical; and figure 8 represents the appearance presented at the point of reversal for the other principal meridian, twenty degrees from the horizontal.

Its direction is always that of the principal meridian, at whose point of reversal it is seen; and it is more pronounced:

In proportion to the degree of astigmatism: The nearness of the observer's approach to the point of reversal: And the perfection of the focusing of the light upon the retina in the direction perpendicular to this principal meridian, that is, in the other principal meridian.

In estimating astigmatism by skiascopy, two distinct things are to be done, which require different arrangements of the source of light. The first is to determine accurately the direction of the principal meridians by bringing out most distinctly this band-like appearance in

the pupil, indicating the direction of one of these principal meridians; the other being always, for regular astigmatism, at right angles thereto. The second thing to be done is to measure accurately the refraction in each of these principal meridians.

The test proceeds at first as for myopia or hyperopia in a non-astigmatic eye, until a point of reversal is found. Then it is discovered that this point of reversal is only for the movement of light and shadow in one direction, and does not hold for movements at right angles to that direction. The observer has now brought his eye to one point of reversal where the band-like appearance can be best perceived. But, as he has been working with the original source of light in the position most favorable for the measurement of hyperopia and myopia, the position that brings the immediate source of light as close as possible to the mirror, he may see very little appearance of the band in the pupil, even with the higher degrees of astigmatism.

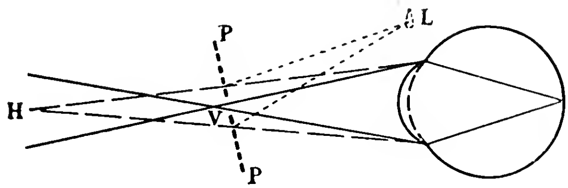


Fig. 9. Skiascopy.
Conditions to Bring out Band in Pupil most Clearly.

The reason for this is, that with the immediate source of light in this position, the light is most accurately focused on the retina in the direction that the band should take. And, in the direction at right angles to the band, the diffusion at what should be the sides of the band partly or entirely neutralizes the effect produced by the greater magnification of the retina in the direction of the band.

In order to bring out this band-like appearance, it is necessary to make the focusing from side to side of the band as perfect as possible. And, to secure the perfect focusing in the principal meridian at right angles to the one in which the band is sought, the immediate source of light must be brought to the point of reversal for that other principal meridian. The band-like appearance of astigmatism is most perfectly developed when the observer's eye is at the point of reversal for one principal meridian, and the immediate source of light at the point of reversal for the other principal meridian.

In figure 9, the solid lines represent the vertical meridian of an astigmatic eye; and the rays emerging, so turned in that meridian as

to give the point of reversal at V. The broken lines represent the less curved horizontal meridian of the cornea, and the rays so turned in that meridian as to give a point of reversal at H. The dotted lines represent a plane mirror, PP, with the eye of the observer at V, and the light L pushed off from the mirror, so that the rays enter the eye as though they came from H, and are perfectly focused on the retina in the horizontal meridian, rendering most distinct the appearance of a vertical band.

For illustration, suppose a case [which the student will do well to reproduce for actual study, either in the artificial eye or by lenses placed before the living eye] having compound myopic astigmatism, the vertical meridian of the cornea being 2 D. myopic and the horizontal meridian 1 D. myopic. When, with the plane mirror, the observer's eye is one-half metre from the observed eye, it will be at the point of reversal for the vertical meridian, and in a position to see a vertical band of light. But, if the source of light be placed as close to the mirror as possible, the rays from it will be the more accurately focused upon the retina in the vertical meridian and more diffused horizontally, so that the real form of the retinal light area will be rather that of a horizontal line or band.

Now, from the observer's position, the retina is most magnified in the vertical direction, and this vertical magnification would cause a point of light on the retina to appear as a vertical band in the pupil; but, with the light area really in the form of a horizontal band, the effect of the vertical magnification is largely neutralized, and the appearance in the pupil may be quite indefinite.

To bring out the band-like appearance: While keeping the observer's eye and mirror in the same position, the original source of light must be pushed off from the mirror one-half metre, the immediate source then retreats correspondingly behind the mirror, and approaches the position of the point of reversal in the horizontal meridian, one metre from the eye.

With the light and mirror in this relation to the eye, the rays are perfectly focused upon the retina in the horizontal meridian and diffused in the vertical meridian, so that the real form of the retinal area of light is a vertical line or band. This vertical line or band being viewed from the point of reversal of the vertical meridian (where it will be greatly magnified in the vertical direction and but slightly magnified in the horizontal direction), gives rise to the appearance of the most distinct vertical band of light in the pupil. And, under these conditions, the presence of the astigmatism and the direction of one of its principal meridians is most strikingly revealed.

Taking the same case and using the concave mirror at a distance of one metre, which is the point of reversal for the horizontal meridian, the appearance of a horizontal band of light in the pupil may be rendered most distinctly visible. But, in order to develop it clearly, it will be needful to bring the original source of light to such a position that the immediate source will be one-half metre in front of the mirror; that is, one-half metre in front of the observed eye, at the point of reversal for the vertical meridian. For it is from this position the light will be most perfectly focused on the retina in the vertical meridian, while diffused in the horizontal meridian, and the greater horizontal magnification of the retina at the point of reversal for the horizontal meridian where the observer's eye is placed, will emphasize and increase the appearance of the horizontal band of light then thrown on the retina.

With the *plane* mirror the source of light is always back of the mirror, and cannot be brought in front of it, and the direction of the band can only be accurately determined for the meridian whose point of reversal is nearest the eye. Only with the eye and mirror at this point of reversal that one is able, with the plane mirror, to bring the immediate source of light to the other point of reversal. With the concave mirror, the immediate source of light is in front of the mirror, and the band-like appearance can only be distinctly brought out in the meridian which has its point of reversal the farther from the eye, as only with the eye at that point of reversal can the immediate source of light be brought to the other point of reversal.

With either the plane or concave mirror, only the band in one principal meridian can be distinctly developed. But it is unnecessary in practice to bring out the bands in both meridians, since, by knowing the direction of one principal meridian, the other being always perpendicular to it, is also known.

The measurement of the refraction in either of the principal meridians of astigmatism, is quite similar to the measurement of refraction in hyperopia and myopia.

When the refraction in each of these meridians has been approximately ascertained the correcting cylinder should be placed before the eye and the refraction again measured. The importance of thus using cylinders has been urged by Duane (*Ophthalmic Record* v. **12**, p. 420). Pannell (*Ophthalmology* v. 9, p. 49) sought to determine the principle meridians exactly by turning the correcting cylinder first one way from its supposed position, and then the other. As soon as this caused a perceptible band appearance the position of the cylinder was noted and the point midway between these two positions was taken as the true direction for the principle meridian.

Changes in the light area at different distances. In regular astigmatism, supposing the eye to be myopic in all meridians, or a convex lens placed before it sufficiently strong to over-correct the hyperopia in all meridians, the observer using a plane mirror and viewing the eye from different distances, will be able to recognize the following changes in the appearance and movement of the light in the pupil:

From a position nearer the point of reversal of the more myopic meridian, the light will be seen to move with the light on the face, in all directions. As the observer's eye is withdrawn from the observed eye, and approaches the point of reversal for the more myopic meridian, the light area in the pupil becomes elongated in this meridian; and, while the movement is still with the light on the face in all meridians, it becomes more rapid in the direction of this elongation than in the direction perpendicular thereto.

The observer withdrawing his eye still farther, on reaching the point of reversal for the more myopic meridian [V, in figure 9], is unable to distinguish the movement in this meridian, while the movement in the meridian at right angles to it is still with that of the light on the face.

This point being reached, if the original source of light be pushed away from the mirror, so that its reflection, the immediate source of light approaches the point of reversal for the less myopic meridian, the form of the light in the pupil becomes a distinct band running in the direction of the more myopic meridian, readily seen to move from side to side, but without perceptible movement in the direction of its length.

Bringing the source of light back to its usual position close to the mirror, and withdrawing his eye still farther from the eye under observation, the observer again sees the movement of the light in the pupil in all directions. But in the direction of the most myopic meridian, it is now against the light on the face; while in the meridian at right angles to this, it is still with the light on the face. The band-like appearance is now lost entirely; the area of light in the pupil taking at one distance the same shape as though no regular astigmatism were present.

But, as the point of reversal for the less myopic meridian is approached, elongation in the direction of that meridian may be noticed, and the movement of the light in that meridian with the light on the face becomes more rapid than the movement against the light on the face now seen in the more myopic meridian. When the point of reversal for the less myopic meridian [H, figure 9] is reached, the movement in its direction ceases, but it is impossible, at this point (with

the plane mirror), to bring out so distinct a band as was seen in the direction of the other meridian.

Withdrawing still farther, the light in the direction of the less myopic meridian begins to move against the light on the face, at first very rapidly as compared with the movement in the more myopic meridian. But, as the observer withdraws farther from this second point of reversal, the difference in rate of movement in the two meridians becomes less noticeable.

With the concave mirror, the same series of appearances are presented, except that the directions of movement are reversed—the erect image seen from within the point of reversal giving movement of the light in the pupil against the movement of the light on the face, and against the mirror; and the inverted image seen from beyond the point of reversal giving movement of the light in the pupil with the mirror and with the light on the face. With the concave mirror the

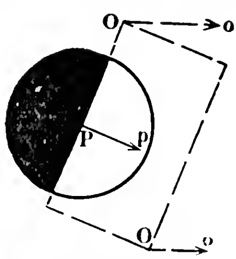


Fig. 10. Skiascopy.
Showing Why the Light Seems to Move at Right Angles to its Border.

meridian in which it is possible to bring out the band-like appearance of the light most distinctly is the meridian of less myopia. With such a mirror it will also be necessary to bring about the series of changes in the movement of the light area, which has been referred to, by changes of the lens placed before the eye, and not by changes in the observer's distance from the eye studied.

Direction and movement of the bands in astigmatism. The constant conformity of the direction of these bands of light to the principal meridians of refraction depends on the magnification of the retina. That conformity sharply distinguishes them from the somewhat similar appearance seen near the point of reversal in eyes free from astigmatism.

The apparent movement always at right angles to their direction is dependent on an optical illusion, of which one may satisfy himself by making a hole in the centre of a sheet of paper, holding behind this hole the edge of a card, and moving it in a direction oblique to

this edge. The motion will appear to be in a direction nearly or quite perpendicular to the edge seen.

Thus, in figure 10, the real movement of the card behind the opening, or the band of light behind the pupil, may be in the direction O o. But the movement will appear to be in the direction P p.

Pendulum movement. In many eyes when the band of light is made to move across the pupil, it does not keep the same direction all the way across. But it appears on one side of the pupil to have a direction different from that which it has on the other side. Thus on the right side of the pupil, the band may have the direction of 75°, yet when moved to the left side, it has the direction of 105°. When moved from side to side, it appears to swing like the pendulum of a clock, around some fixed point. This fixed point may seem to be above the pupil, or below it, or to one side. R. D. Batten has pointed out (*Ophthalmic Review*, Jan., 1897) that this behavior of the band of light resembles what is seen in conical cornea, except that with the pendulum movement, the apex of the cone is entirely beyond the edge of the cornea. He has suggested that this condition be called conical astigmatism. The pendulum movement is liable to mislead the surgeon as to the direction of the meridians of astigmatism. This must be guarded against by carefully noting its direction, when passing across the center of the pupil.

Appearances of irregular astigmatism. To the beginner with skiascopy, these constitute the most serious obstacle he has to encounter. One who has mastered the principles of the test and become familiar with the various appearances of light and shade in the pupil, can avoid the mistakes due to aberration or irregular astigmatism. To the experienced skiascopist these reveal the reason for uncertainty in the results obtained by other methods, or of failure to secure perfect vision on account of these defects.

If we suppose two parts of the pupil, one of which has its point of reversal at the observer's eye, while the other is at a considerable distance therefrom, the illumination of the former will be the more feeble, of the latter the more brilliant; the movement of the light in the former, if perceptible, will be rapid, in the latter, slow. If one watches two parts of the pupil, one of which has its point of reversal back of the observer's eye, and the other in front of it; in the former the light will have a direct and in the latter an inverted movement.

With the irregular astigmatism due to preceding corneal inflammation, or to the changes in the refraction of the lens that sometimes precede cortical cataract, the pupil appears broken up into a considerable number of distinct areas, each of which has its separate move-

ment of light and shadow, constituting the typical ophthalmoscopic or skiascopic picture of irregular astigmatism. The appearance caused by irregular astigmatism following corneal disease is shown in figure 11. That due to change in the lens such as may precede cortical senile cataract is shown in figure 12, in which the black lines represent fixed spicules of actual opacity, while the other parts of the pupil indicate merely refractive differences, and change from light to dark, or dark to light, as the inclination of the mirror is varied. Such an appearance is sometimes presented by young persons, indicating a congenital defect which may not noticeably increase in many years.

If the differences of refraction in the different parts of the pupil are slight—that is, if the aberration or irregular astigmatism is of low degree—these differences of illumination and movement will not be perceptible until the observer brings his eye close to the point of reversal. But at the point of reversal, they become perceptible and constitute a striking phenomenon in most eyes. To the observer who does not understand their significance, they are extremely confusing. In the nature and arrangement of its irregular astigmatism, every eye is peculiar. The varieties of play of light and shade that are obtainable as the point of reversal is reached, are as numerous as the eyes examined. Even the two eyes of the same individual differ.

Fig. 11. Skiascopy.
Irregular Astigmatism Left by Corneal Disease.

Fig. 12. Skiascopy.
Irregular Astigmatism Due to Lens Changes.

Symmetrical aberration. This is an error of the refraction of the eye which causes the rays of an incident pencil falling on the same meridian of the cornea, but at different distances from the axial ray, to meet at different distances behind the cornea, while rays piercing different meridians of the cornea, at the same distance from the axial ray, intersect it at the same point. (See paper by the author, *Trans. Amer. Ophthalmological Society*, 1888, p. 141.) It is a defect similar to the monochromatic aberration of convex and concave spherical lenses. (See v. XIII, p. 9836 of this *Encyclopedia*.) It is readily

recognizable in almost all eyes by skiascopy. In the majority of cases, it is in the same direction as ordinary spherical aberration; that is, near the margin of the pupil there is a stronger lens action than near the centre—the rays entering through the margin are brought to a focus first, the rays entering nearer the centre being focused farther back. This is called positive aberration. (See Fig. 52, p. 9836, Vol. XIII of this *Encyclopedia.*)

In a certain proportion of cases, however, the defect is in the opposite direction; the rays passing near the centre of the pupil are brought first to a focus, and those passing through the periphery are focused farther back. The centre of the pupil has the stronger, and the periphery of the pupil the weaker, lens action. This is negative aberration.

The visual zone. The variation of refraction, however, does not usually proceed regularly from the centre of the pupil to the margin. The central refraction is comparatively uniform over a considerable area; and, towards the margin the change of refraction becomes progressively more marked. This area in the centre of the pupil of comparatively uniform refraction is the usual visual zone. It is the portion of the pupil that is of practical importance for purposes of distinct vision. Its size varies considerably. Sometimes it includes almost the whole of the dilated pupil, in other eyes an extremely small area near the centre of the pupil will be regular, and the remainder of the pupil useless for accurate vision. If a high degree of irregular astigmatism be present, the visual zone, instead of being a central area of considerable size, will often be some particular portion of the undilated pupil, which happens to have the most regular curvature.

For the correction of ametropia, it is the behavior of the light and shade in the visual zone which has to be studied. Its behavior elsewhere may be disregarded. It is often much easier to watch the movement of light and shade in some other portion of the pupil—some part of the extra-visual zone. And, if the observer does not understand their relative importance, he will be apt to fix his attention on this latter, and be led away from the true refraction of the eye he is examining. This is the more likely to happen, because in that part of the pupil, which has its point of reversal at, or near, the observer's eye, the direction of the movement of light and shade is difficult to see, while in other portions, the movement is more striking.

The appearances of positive aberration. The appearances presented by an ordinary case with positive aberration may be considered in the order in which they will be developed with the plane mirror, the ob-

server starting to examine the eye from nearer than the point of reversal for the most myopic part of the pupil, and gradually withdrawing his eye until it is beyond the point of reversal for the least myopic part of the pupil. From the first position, the light area in the pupil is seen to move with the light on the face entirely across the pupil; its motion in the edges of the pupil being more rapid than in the centre. If, now, the observer's eye is withdrawn to the point of reversal for the margin of the pupil, there appear in the margin points in which no movement of the light can be seen. Some of these may be points of stationary light, and others, points of stationary shadow.

As the observer's eye is still farther withdrawn, the points of stationary light run together and form a complete ring of light in the periphery of the pupil, shown in figure 13, which is presently seen to have an inverted motion—to move against the light on the face.

Fig. 13. Skiascopy.
Positive Aberration Seen Near Point of Reversal for Edge of Pupil.

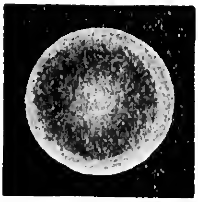


Fig. 14. Skiascopy.
Aberration from Near Point of Reversal for Center of Pupil.

Within this is a ring of comparative shadow where the movement is swift, and difficult or impossible to recognize; and still within this lies an area of light—what remains of the light area first seen, now considerably reduced in size—which still moves with the light on the face.

As the observer draws still farther back, this area of light at the centre of the pupil, as shown in figure 14, grows smaller, and its movement more difficult to certainly distinguish. The ring of comparative shadow around it encroaches upon it, and the ring of light in the margin of the pupil in turn encroaches upon the shadow, and becomes brighter and its movement more readily noticeable.

Withdrawing still farther, the point of reversal for the centre of the pupil is reached. The central area of light becomes faint and its movement ceases to be noticeable, the ring of feeble illumination surrounding it having swallowed it up. But, around this feeble light area, the ring of inverted movement has now grown broad and distinct. And, as the observer withdraws still farther, this ring of in-

verted movement closes in until it occupies the whole of the central area, and the observer sees an area of light moving across the whole pupil, having an inverted movement—that is, against the mirror or light on the face.

The movements of these erect and inverted light areas in the pupil are illustrated by figures 15 and 16. Figure 15 shows the plane mirror turned to the left, or the concave mirror turned to the right, the central erect area being displaced toward the left, and the peripheral inverted area toward the right of the space it occupies. Figure 16 represents the light areas displaced in the opposite directions by an opposite inclination of the mirror.

With the concave mirror, a similar series of changes may be brought about by placing before the eye successive strengths of the lenses, beginning with the weakest convex or strongest concave. The first should allow the points of reversal for all parts of the pupil to be

Fig. 15. Skiascopy Shadows.

Fig. 16. Skiascopy Shadows.

back of the observer, and the successive changes bring these points closer and closer to the observed eye until all are in front of the observer. The movement is at first against the light on the face. Then appears the ring of illumination and swift movement in the margin of the pupil with the light on the face. The central area of light is then encroached upon by the ring of faint illumination, and this in turn by a ring of more brilliant illumination in the margin, moving with the light on the face, which latter finally occupies the whole area of the pupil.

If the point of reversal be approached from the opposite direction, with either the plane or the concave mirror, the succession of appearances in the pupil will be reversed.

Appearances of negative aberration. With negative aberration, the series of changes is apt to be less regular and complete, and the picture presented by the pupil is less characteristic. The succession of appearances is the reverse of what has been described for positive aberration.

With a plane mirror starting closer to the patient's eye than the point of reversal for the most myopic part of the pupil, the movement is with that of the light on the face throughout the whole pupil. As the observer's eye is withdrawn to a greater distance, this movement becomes indefinite, and the light feeble near the centre of the pupil. Presently, the movement at the centre of the pupil is lost, while still quite distinctly with that of the light on the face in the irregular ring-shaped area of the periphery. Withdrawing still farther from the eye, the inverted movement at the centre of the pupil becomes distinctly visible, and the direct movement near the margin comes more encroached upon and less distinct, until all erect movement is lost and we have only the inverted movement, which extends across the whole pupil. Before the erect movement entirely disappears, it is apt to break up into small areas detached from one another by spaces of comparative shadow, but each presenting some remnant of the erect movement.

With the concave mirror, starting with a convex lens so weak, or a concave lens so strong, that the point of reversal is back of the observer, we have the opposite succession of movement against changing to movement with light on the face.

While the order of their development remains the same, the exact character of the appearances presented varies with the degree of aberration. Generally, in the higher degrees, the areas of light occupy the greater part of the pupil and the area of feeble illumination separating them is comparatively narrow. While in very low degrees of aberration, the area of feeble illumination is broad, and it may be difficult to recognize more than one of the light areas at one time.

Skiascopy in conical cornea. This is a condition in which the variations of the refraction, instead of being confined to the periphery of the pupil, encroach greatly upon the normal visual zone. In such eyes the skiascopic appearances of aberration are striking and characteristic.

The error of refraction produced by conical cornea is a high degree of negative aberration. At the apex of the cone, the curve is sharp, causing, usually, very high myopia in the corresponding part of the pupil. The sides of the cone, on the other hand, are comparatively flat, causing diminished myopia as the region of the apex is departed from and sometimes running into hyperopia near the edge of the pupil.

If the observer's eye be placed as it usually is, somewhere near the point of reversal for the periphery of the pupil, the movement of light in that portion of the pupil will be rapid, but the movement in

the portion of the pupil corresponding to the apex of the cone will be slow, because the point of reversal for this part of the pupil is very close to the patient's eye, and, generally, many dioptres removed from the observer's eye. The movement of light in the pupil, then is slow near the centre and rapid towards the periphery, causing the area of light to appear to wheel around a fixed point corresponding to the apex of the cone. The light area is first seen on one side of the pupil, then on the other, but always reaching to the central fixed point.

The form of this light area will be often triangular, its base resting on the margin of the pupil and its apex at the apex of the corneal cone. Sometimes the triangle covers almost half of the pupil, in other conditions of light it is considerably narrower, but the constant and characteristic phenomena is the wheeling of the light area about the fixed point at the apex.

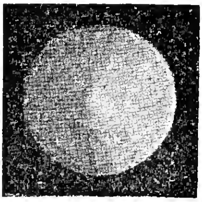


Fig. 17. Skiascopy.
Appearances Seen in High Aberration and Conical Cornea.

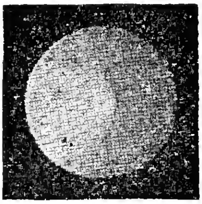


Fig. 18. Skiascopy.
Appearances Seen in High Aberration and Conical Cornea.

This is shown in figures 17 and 18, which represent the appearances of the pupil with the mirror inclined in opposite directions.

It was for the detection of these appearances, to which attention was called by Bowman, in 1857, that the test was first employed. Bowman mentions that he was able by means of it to detect low degrees of conical cornea, which could not be detected in any other way. It is certain that among cases that have thus been classed as low degrees of conical cornea, on account of their presenting such appearances, some were not of conical cornea at all, but were cases of high aberration from other forms of defect in the dioptric surfaces.

The appearances in question occur in all cases of high aberration; and cases of high positive aberration are more common than cases of true conical cornea. The conditions for their recognition are that the observer's eye shall be comparatively near the point of reversal for the margin of the pupil, and comparatively far removed (estimating by dioptres) from the point of reversal for the centre of the pupil. By careful management of the light and relative position of

observer and patient, something of such an appearance can be demonstrated in the majority of eyes.

Like the band-like appearances of the light in astigmatism, those of conical cornea reveal the presence of the condition and the location of the apex of the cone, but beyond this, they are of little practical value.

The series of movements presented in positive aberration can be well studied in the numerous forms of artificial eye, in which spherical lenses are used to represent the dioptric surfaces. The appearances presented by negative aberration can only be studied in eyes having this condition of refraction.

Scissors-like movement. A special form of irregular astigmatism exists, of sufficiently frequent occurrence and striking character to merit special description. One portion of the pupil, as an upper or lower half, is more myopic in a certain meridian than is the other

Fig. 19. Skiascopy.
Scissors Movement. Bands Separated.

Fig. 20. Skiascopy.
Scissors Movement. Bands Coming Together.

part of the pupil. This causes an inverted movement of light in the one portion of the pupil, while there is an erect movement in the other. These two areas are distinct, and separated by an intermediate zone of feeble illumination. As the light is made to move back and forth in the proper direction, the two areas of light in the pupil are seen alternately to approach and separate, narrowing or widening the intermediate zone. As the areas, under these circumstances, are generally band-like, the effect is similar to that of the opening and closing of a pair of scissors. These appearances are represented in figure 19, which shows them with the mirror so turned as to separate the two areas; and figure 20, which represents them brought together by an opposite inclination of the mirror.

The relative size of the two areas will depend on the distance of the observer from the eye or upon the strength of the lens employed. As the observer withdraws to a greater distance, or the convex lens is made stronger, or the concave lens is made weaker, the area of in-

verted movement encroaches upon the zone of feeble illumination separating the areas of light and the area of erect movement diminishes. As the observer comes closer to the eye, or the convex lens is made weaker or the concave lens stronger, the area of inverted movement diminishes. Always the observer's eye is near the point of reversal for the intermediate zone of feeble illumination; and, in making the determination of the refraction for practical purposes, care must be taken to see that this zone is brought to a portion of the pupil that is available when the pupil is contracted, as under ordinary conditions of illumination and near work. See **Scissors movement.**

The scissors-like movement may be produced in an artificial eye by placing the lens which represents the dioptric surfaces, so that the light passes through it obliquely. It may also be developed in most eyes by applying skiascopy in some direction at a considerable angle from the optic axis. Its presence in the eye indicates obliquity or imperfect centering of one or more of the dioptric surfaces. Eyes

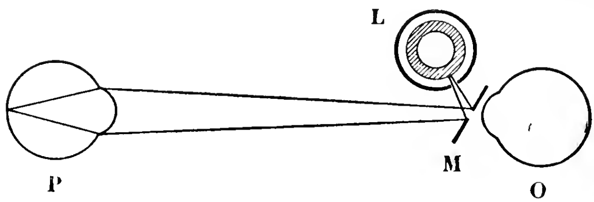


Fig. 21. Skiascopy.
Position of Light and Eyes in Using the Plane Mirror.

presenting it demand special care to develop the best vision they are capable of with correcting lenses.

PRACTICAL APPLICATION OF SKIASCOPY WITH THE PLANE MIRROR.

The room being thoroughly darkened, the patient and surgeon take positions facing each other at a disatnce of about one metre, with the original source of light close to the surgeon on the side of the eye he desires to use, that is on the right if he intends using his right eye for the test. He can really see the movement of light and shade in the pupil with but one eye at a time; yet he will find it more pleasant to work with both eyes open if he once learns to do so. The source of light should be freely movable from fifteen centimetres in front of the patient's face to over a metre away. The light is covered from the patient's face, and also from the surgeon's except at the aperture of about five millimetres opposite the brightest part of the flame. The arrangement of the surgeon and patient with reference to the light

is shown in Fig. 21, in which L represents the light, M the mirror, and O and P the eyes of the observer and patient.

The mirror is held so that the surgeon can watch, through the sight hole, the movement of light on the patient's face; and turned until the area of light that it reflects falls with its centre upon the eye to be tested, the centre being marked by the spot of feeble illumination, corresponding to the sight hole of the mirror.

With the light properly directed, the pupil appears to be partly or wholly occupied by a red glare, the light area with which skiascopy is especially concerned. In first attempting the test, care must be taken to discriminate clearly between this general red glare and the reflection from the cornea or from the surfaces of any lens that may be placed before the eye. The reflection from the cornea is small and brilliant, a mere point of light, if the room be thoroughly darkened. The reflections from the lens employed are larger and more confusing. They may be avoided by tilting the lens slightly, which causes them to pass off to the periphery, leaving the centre of the lens free from reflection.

SKIASCOPY IN HYPEROPIA.

If the mirror be rotated about a vertical axis, that is if it be made to incline more to the right or left, the area of light in the pupil will be seen to move with the light on the face to the right or left as the inclination of the mirror changes. If the rate of movement be slow, the hyperopia is of high degree, if more rapid, it is lower.

A convex lens is now to be placed before the eye, and this rate of movement of light in the pupil is the guide to the probable strength of lens required. If the observer has not sufficient experience with skiascopy to judge the strength of the lens required, he will save time by placing before the eye rather a strong lens, one of say 5 D. With this the light is again thrown upon the eye, if the lens be not sufficient to correct the hyperopia, the movement of light in the pupil will still be with that of the light on the face, and a still stronger lens must be used. This strengthening of the convex lens is continued until one is found which does cause reversal of the apparent movement of light in the pupil, so that the light in the pupil moves against the light on the face.

Then the surgeon approaches the patient, rotating the mirror and watching for the nearest point at which he still sees the inverted movement in the visual zone. Near this point, the illumination of the pupil

becomes feeble; and the movement, rapid, requiring the closest watching. Approaching still nearer to the patient the light in the visual zone is seen to move with the light on the face, and the greatest distance at which this can be distinguished is to be noted. Between these two, the least distance of inverted movement, and the greatest distance of direct movement lies the point of reversal. Generally one may take the greatest distance at which direct movement can be perceived as the point sought.

The distance from the surgeon's eye to the patient's eye then measured is the focal distance of the lens correcting the myopia produced by the convex lens employed. This subtracted from the strength of the lens will give the amount of hyperopia in the eye.

Having ascertained about the refraction and having repeated the various observations until no doubt is left as to their correctness, the lens before the eye is to be changed for one sufficiently weaker to carry the point of reversal to about one metre where the estimate of the ametropia is to be completed.

For example: Suppose the eye under examination to have hyperopia of 3 D. When the 5 D. lens is placed before it, the point of reversal will be brought to one-half metre. As the surgeon's eye is made to approach that of the patient, the inverted movement in the visual zone will cease when they are about 60 centimetres apart. Going still closer, the erect movement will be distinguished at about 40 centimetres. These observations are to be repeated until the surgeon makes sure that the point of reversal lies somewhere between 40 and 60 centimetres. The 5 D. lens is then replaced by the 4 D. lens. Repeating the test, the inverted movement is seen as near the eye as one and one-quarter metres and the direct movement almost as far away as one metre. This locates the point of reversal at about 1 metre from the eye, and determines the myopia caused by a 4 D. convex lens to be 1 D., and the refraction of the eye to be 4. D.—1 D.= 3 D. of hyperopia, with less than 0.25 D. of possible error either way.

SKIASCOPY IN MYOPIA.

In myopia the first rotation of the mirror will usually cause a movement of light in the pupil against that of the light on the face. The surgeon then approaches the patient, until this apparent movement becomes rapid and indefinite and presently is entirely lost. Approaching still closer to the patient's eye, the movement of the light area in the pupil again becomes distinct, but is now with the movement of

the light on the face. A point midway beween these is the point of reversal.

The distance of this point of reversal from the patient's eye is the focal distance of the lens that will be required to correct the myopia. But for accuracy, a lens about 1 D. weaker than such correction is placed before the eye to bring the point of reversal to the distance of one metre; and the test is repeated.

Suppose the eye to be 6.5 D. myopic. With the first test the inverted movement will be perceived up to about eight inches from the patient's eye; and at five or six inches from the eye an erect movement will begin. From this, the surgeon may assume that the myopia is about 7 D. [focal distance 6½ inches] and place before the eye, for the more accurate test, a concave 6 D. lens. On trying the movement of light in the pupil through this lens, it will be found at the distance of one metre to be with that of the light on the face. The surgeon then draws back until the direct movement becomes indistinguishable and at two metres is entirely lost. Often, however, the distance of two metres will be found too great to be sure of the movement in the visual zone. In such a case the —6 D. lens will need to be replaced by a weaker lens as a —5.5 D., with which the erect movement will be seen to almost a metre, and the inverted movement will begin a few inches beyond that point.

If the myopia be very low, the first inspection of the pupil without a lens may show a movement of light in it with the light on the face. In such a case, the surgeon will draw back as far as he can readily distinguish the movement of light in the visual zone. If the movement still appears to be with that of the light on the face, he will place before the eye a convex lens, and with it determine the point of reversal as for a case of hyperopia. The final result of testing, however, will show that the myopia caused by the lens is greater than the strength of the lens, and, therefore, that some myopia must have been present before the lens was placed in front of the eye.

For example: Suppose that before reaching that distance of two metres the erect movement in the pupil becomes indistinct, and that the visual zone, where the movement must be watched, is so small that beyond this the direction of movement in it cannot be recognized with certainty. A + 0.5 D. lens being placed before the eye is found to cause an inverted movement beyond 125 centimetres, and to confine the erect movement to within 85 or 90 centimetres of the eye. The point of reversal then, is at one metre. The amount of myopia corresponding to this is 1 D., of which 0.5 D. was caused by the lens and 0.5 D. was the amount originally present in the eye.

SKIASCOPY IN EMMETROPIA.

On first inspection, without a lens, the surgeon sees an erect movement in the pupil, the rapidity of which indicates that if there be hyperopia it is of low degree. Drawing back from the patient's eye as far as possible, however, this erect movement still continues. He places before the eye under observation a convex lens of 1 or 2 D., and viewing the movement of light in the pupil through this lens, finds the distance of the point of reversal from the patient's eye, exactly corresponds with the focal distance of the lens he has been using. That is, the lens has caused myopia just equivalent to its own strength, showing that before they passed through the lens, the rays emerging from the cornea were parallel.

SKIASCOPY IN REGULAR ASTIGMATISM.

The test will proceed at first as for simple hyperopia or myopia, unless the astigmatism is so high that the first inspection, without any lens, reveals an unmistakable band of light, or there is erect movement in one meridian and inverted movement in another, or that the movement of light in the pupil is notably more rapid in some one meridian than in the meridian at right angles to it.

Commonly, the first appearance gives no positive indication of the presence of astigmatism, and the test goes on until a point of reversal is found. Then, on trying the movement of light and shade in different meridians, as should always be done from near the point of reversal, it is discovered that it is the point of reversal for only one meridian; and that for the meridian at right angles to that one, there is a distinct movement of the light either erect or inverted.

If inverted movement is noticeable from the point of reversal first discovered the surgeon should bring his eye closer to the patent until this inverted movement ceases. He will then be near the point of reversal for the meridian in which the inverted movement was noticed, and will be able to see in the other meridian an erect movement.

Such a lens is now to be chosen and placed before the eye as will bring this point of reversal for the more myopic meridian—the point of reversal from which an erect movement is seen in the other meridian—to a convenient distance from the eye. The surgeon's eye is placed as nearly as possible at this point of reversal. Then the original source of light [which up to this stage of the test has been left close to the mirror] is pushed away from the mirror, and while it is pushed away, the mirror is rotated and the light area in the pupil watched. This

light area will now be seen to assume the band-like appearance characteristic of astigmatism.

At a certain distance this band-like appearance will be most distinct. With the source of light nearer the mirror or farther from the mirror, it will be less characteristic. The distance of the light from the mirror at which the band becomes most distinct is the distance between the two points of reversal. The surgeon's eye (with the mirror) is now at the point of reversal for the more myopic meridian, and the immediate source of light is at the point of reversal for the less myopic meridian. (See Fig. 9.)

With the light in this position, the direction of the band is observed and noted as the direction of one of the principal meridians of astigmatism. It is the direction for the axis of the convex cylinder that will correct the astigmatism. The other principal meridian will, of course, be perpendicular to this.

Having fixed the direction of the principal meridians the surgeon brings the original source of light as near to the mirror as possible, and proceeds to measure the refraction, first in the one principal meridian and then in the other, just as he would in a case of hyperopia or myopia. The difference between the refraction of the two principal meridians is the amount of astigmatism.

To measure the refraction in a certain meridian the light is made to move on the face, and on the retina, in the direction of this meridian by rotating the mirror about an axis perpendicular to it. Thus for the vertical meridian the light is made to move vertically by turning the mirror about a horizontal axis. For the horizontal meridian the light is made to move horizontally, by turning the mirror about a vertical axis. Great care is necessary in the higher degrees of astigmatism to make the movement conform accurately to the meridian to be tested, since any oblique movement will appear (see Fig. 10) as though perpendicular to the band.

When the astigmatism is of very low degree, 0.5 D. or less, it is difficult to distinguish between the points of reversal for its principal meridians. The band-like appearance of the light in the pupil becomes less characteristic, and there is no space between the two points of reversal where an erect movement can be obtained in the direction of one meridian, and a reverse movement in the direction of the meridian perpendicular to it. In these cases, the astigmatism is to be recognized by the fact that when, near one point of reversal, the movement in one meridian has become indistinguishable, it can still be perceived in the other principal meridian. It is upon this behavior of light in the pupil under these conditions that the diagnosis of the very low degrees of astigmatism must principally rest.

The final test in any case will be made with such a cylindrical lens as will correct the astigmatism together with the spherical lens which will bring the point of reversal to the desired distance—about one meter.

If it is found that the reversal occurs at the same distance from the eye for all meridians, the cylinder chosen is known to be correct, both as to strength and as to the placing of its axis.

If, however, the movement of light is found to cease in some meridian, but to continue (either direct or inverted) in a meridian at right angles thereto, it becomes evident that the cylinder chosen does not perfectly correct the astigmatism. If this remaining astigmatism has the same principal meridians as those already fixed upon, the direction of the axis of the lens is correct, but its strength is not exactly right.

If the astigmatism remaining after the cylindrical lens has been placed before the eye has principal meridians that do not correspond with those for which the lens is placed, the placing of the lens is incorrect, and the direction of its axis needs to be slightly varied, until the remaining astigmatism disappears or its direction corresponds with that of the lens before the eye.

When the meridians of any remaining astigmatism have thus been made to conform to the direction of the cylindrical lens before the eye, this remaining astigmatism has to be corrected by a change in the strength of the cylindrical lens.

For example: Suppose an eye having a compound hyperopic astigmatism corrected by + 1. sph. ⊃ + 1. cyl. axis 95°. The first inspection of the movement of light in the pupil shows a movement with that of the light on the face in all meridians, and a difference in the rate of movement in the different meridians so slight as probably to escape notice. A convex 3 D. spherical lens will cause the movement in the pupil to be against the light on the face in all meridians when the eye is viewed from a greater distance than one metre. But it will also be noticed that the light moves more swiftly from side to side than it does upward and downward.

If now the surgeon brings his eye closer to the patient, when the distance of one metre is reached, the movement of the light from side to side becomes indistinguishable, while there is still a very distinct movement against the light on the face upward and downward. Approaching still closer, the movement from side to side is seen to be with the movement of the light on the face, the inverted movement still continuing in the vertical meridian. The movement horizontally with the light on the face, at first very rapid, grows slower as the pa-

tient's eye is approached, and the movement—against the light on the face—in the vertical meridian grows more rapid, until at a distance of one-half of a metre, the movement in the vertical meridian becomes indistinguishable, while there is a very clear movement of light, with the light on the face, from side to side.

The point of reversal for the more myopic meridian (more myopic with the lens) has now been reached, and the surgeon keeping his eye at this position pushes the source of light away from the mirror. As he does so, the area of light in the pupil assumes more and more the appearance of a distinct vertical band, readily moved from side to side, but without apparent movement in the direction of its length. This band continues to become more distinct, until the original source of light is one-half metre from the mirror, and the immediate source consequently one-half metre back of the mirror, and one metre from the patient's eye—at the point of reversal for the less myopic meridian. In this position careful observation will show that the band of light in the pupil is not exactly vertical, but has the direction corresponding to the more myopic meridian of 95°. The principal meridians then are located at 5° and at 95°.

Having determined this, the light is brought back as close to the mirror as possible, and the point of reversal for the 95° meridian is determined. To do this it may be advisable to change the convex spherical lens before the eye, but whatever lens is employed, from the results obtained with it, the surgeon deduces the fact that in that meridian the refraction of the eye is hyperopic 1. D. He then proceeds to measure in the same manner the refraction of the eye in the other principal meridian, finding with the convex 3 D. lens that this point of reversal is at one metre, and its refraction, therefore, hyperopic 2. D. The difference between these meridians will be 1. D., the amount of astigmatism present.

To make the final determination, there should be placed before the patient's eye the 1. D. convex cylinder with its axis at 95° and a 2. D. convex spherical lens; with which the point of reversal for all meridians will be found to lie one metre from the eye. If, in the placing of the cylinder, its axis is not made to correspond exactly with the meridian of least hyperopia, there will be found by this test a remaining astigmatism of low degree. Suppose, through carelessness or inaccuracy in the earlier observation, the axis of the cylinder should be placed at 105° instead of at 95°, the remaining astigmatism then would be found to be such as would be corrected by a convex cylinder with its axis at about 70°. But on turning the cylinder before the eye 10° in that direction, that is, to its proper direction at 95°, this

remaining astigmatism would disappear. If, however, instead of the 1 D. cylindrical lens, a lens of 1.5 D. had been placed with its axis at 105°, there would remain an astigmatism which might be corrected by a concave cylinder with its axis at about 70°, and the turning of the cylinder before the eye 10° in that direction [to 95°] would cause the remaining astigmatism to so change that its meridians would be at 5° and 95°, where a measurement of it would reveal the fact that the cylindrical lens employed was 0.50 D. too strong.

Aberration and irregular astigmatism. The difference in the refraction of different parts of the pupil is to be ascertained by measuring the refraction for each part separately, just as though it were a case of simple hyperopia or myopia, care being taken to confine each observation strictly to the little portion of the pupil the refraction of which it is desired to ascertain. The important practical point

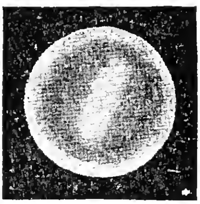


Fig. 22. Skiascopy.
Band Appearances of Astigmatism with Aberration.

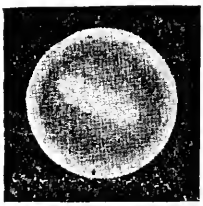


Fig. 23. Skiascopy.
Band Appearances of Astigmatism with Aberration.

about aberration or irregular astigmatism is its distribution. For practical purposes, the surgeon desires to ascertain which part of the pupil is free from such defect, as that part will furnish the best visual zone; and by what lenses that visual zone can be made most useful to the patient. Figures 22 and 23 represent the appearances brought out by thorough investigation of a case of considerable astigmatism, coincident with equally pronounced positive aberration. Without careful study of the visual zone at the proper distances, it would have been easy to set the case down as one of aberration, and to have overlooked the regular astigmatism entirely. If the aberration encroaches decidedly upon the area of the pupil as determined by a moderate light, it may be necessary to give a correcting lens, for use at near work and on exposure to bright light, different from the one required when the pupil will be somewhat larger. Or the surgeon may need to caution the patient that under certain conditions of light he must expect the correcting glasses to give slightly imperfect vision. It is the slight imperfections of this kind situated within the portion of

the pupil used for accurate vision that need to be recognized and taken into account, when prescribing glasses or in giving an opinion as to the value of glasses. These low degrees of imperfection are to be studied after the effects of hyperopia, myopia and regular astigmatism have been excluded by placing the proper glasses before the patient's eyes.

The investigation of aberration and irregular astigmatism is the last step in skiascopy, yet essential to complete certainty and accuracy in the objective measurement of refraction. In a small proportion of cases, it will lead to modification of the glasses previously selected as best, and in a much larger proportion of cases it will discriminate sharply between the lenses which really best correct the ametropia and others which appear to give equally good, or almost equally good, subjective results.

To carry it to completion will often require more time and effort than has been necessary for all other parts of the skiascopic examination. It is not a distinct application of the test, but its application to separate parts of the pupil, instead of to the pupil as a whole. It requires no special directions and cannot be much elucidated by examples. It is to be mastered by a full understanding of the optical principles of the test, strict observance of the conditions of accuracy and the exercise of the needful care and patience.

Measurement of accommodation. The objective determination of the nearest point for which the eye can be focused is possible by skiascopy. It is sometimes of importance as in cases of suspected cycloplegia in children, or others for whom the subjective test cannot be relied on. In determining the condition of the accommodation in an eye with imperfect vision, or in recognizing any slight remaining accommodation after the use of a mydriatic.

The surgeon first ascertains the refraction of the eye, and then places before it such a lens or lenses as will correct astigmatism and bring the point of reversal to a distance of one metre or a little less. He then places himself at this distance from the patient; and directs the patient to fix his gaze upon some object on the farther side of the room, in such a position that the visual axis of the eye under examination shall pass as close as possible to the surgeon's eye. The point of a finger or pencil is then held close to the patient's eye, about the near limit of convergence and in the visual axis, so that the direction of the visual axis shall not be materially changed during the test.

The patient is then directed to look first at the object across the room, then at the point of the pencil close to his eye. The surgeon by watching his other eye can ascertain whether the movements of

convergence are really executed. Very strong convergence being impossible without strong accommodative effort, if any power of accommodation remains, the eye will be seen to grow more myopic when the pencil is looked at, and less myopic when the distant object is fixed, an inverted movement of the light in the pupil becoming apparent on "fixing" the near object and disappearing on "fixing" the other.

To measure the amount of accommodation the surgeon may approach the observed eye until the point of reversal is reached for the eye during very strong convergence; or the lens before the eye may be modified in the direction of weaker convex or stronger concave until the point of reversal is brought, with a new lens and the accommodation, to the same distance as it was brought by the original lens without accommodation. The difference between the lenses in this case represents the amount of accommodation present.

For example: in a case of hyperopia 2 D. to ascertain if accommodation be present a convex 3 D. lens is placed before the eye. This would bring to one metre the point of reversal of the eye with its accommodation relaxed. The surgeon at a little less than a metre gets an erect movement of the light in the visual zone when the patient looks across the room. If now, on looking at the point of a finger held two inches in front of the eye, the movement becomes distinctly inverted, the light in the pupil moving against the light on the face, it is known that accommodation is present. In place of the 3 D. lens a weaker convex may be substituted, and if the strong convergence of the visual axes still brings an inverted movement of light in the pupil, a still weaker lens for this. In this way if it be found that with the 1 D. lens the patient is able by strong accommodative effort to bring the point of reversal to just one metre, the difference between the 3 D. lens and the 1. D.=2. D. will be the amount of accommodation present.

Instead of changing the lens, the surgeon can approximately estimate the amount of accommodation by bringing his eye closer to that of the patient and finding the new position of the point of reversal caused by the exertion of the accommodation.

Mydriatics and cyclopegics in skiascopy. When in the dark room, the pupil fails to dilate to more than 4 mm. in diameter, skiascopy becomes difficult or impossible, and it is necessary to use a mydriatic. For this purpose a 4 per cent. solution of cocain, a 2 per cent. solution of euphthalmin, or a solution of homatropin, 1 to 500, may be dropped in the eye. In persons who have unrelaxed accommodation, and this is sometimes true until fifty years of age or over, it is impossible to be certain of the amount of ametropia, without using a

cycloplegic. Either atropin, daturin, hyoscyamin, hyoscin, or scopolamin may be employed. But homatropin carefully used is equally reliable, and being more brief in its action, should be preferred. To secure complete cycloplegia, a 3 per cent. solution of homatropin hydrobromate should be instilled every five minutes, for half an hour; and the measurements should be made one-half hour after the last instillation.

PRACTICAL APPLICATION OF SKIASCOPY WITH THE CONCAVE MIRROR.

The room should be thoroughly darkened; and to secure this, it is well to have the original source of light shaded. This light will, however, usually be back of the patient, and, except for the determination of the principal meridians of astigmatism, the farther it is behind the patient, the better. Hence, the shading of the light is not essential, as it is with the plane mirror. It is also of less importance that the original source of light should be small. Still the separation of light and shade should be as sharp as possible, so that the opaque shade with an opening opposite to the brightest part of the flame will be found serviceable. The opening in the shade may be two or three centimetres in diameter, so long as the original source of light is a metre or more away from the mirror. But when this is brought near the mirror to bring out the band of light in astigmatism the opening should be one centimetre in diameter or less.

The surgeon places himself with his eye one metre from that of the patient. On throwing the light upon the patient's face with the mirror, it is found that the area of light on the face moves with the mirror just as in the case of the plane mirror. If, however, the light in the pupil be seen to move with the light on the face, the eye is myopic more than 1. D. If the light in the pupil be seen to move against the light on the face, the eye is hyperopic, emmetropic or less than 1. D. myopic.

Hyperopia. If the mirror be rotated about a vertical axis from right to left, the area of the light in the pupil will be seen to move from left to right, that is, against the mirror and against the light on the face. This is really an erect movement, we know from the demonstrations as to the real direction of the movement of the light on the retina. The difference between erect movement and movement with the light on the face must be borne in mind. With the concave mirror, the one is just the opposite of the other. The movement with the light on the face being an inverted movement; and the movement in the pupil against the light on the face the erect movement.

As with the plane mirror, the movement will be swift if the hyperopia be of low degree; slower, if of higher degree. The convex lens is now to be placed before the eye, the swiftness of the movement in the pupil being the guide to the strength probably required. If the observer is not able to judge by this movement, let him at first employ in succession lenses that differ considerably in strength, as the 2, 4, and 6. D., increasing the strength as long as the movement in the pupil is against the movement on the face.

When a lens is reached that causes movement of light in the pupil with the light on the face, slightly weaker lenses are to be tried until the two consecutive lenses are found, of which one gives the movement against the light on the face and the next stronger causes movement with the light on the face. Between these two lies the lens strength which would bring the point of reversal to the surgeon's eye. The surgeon's eye being one metre from the patient, this is the lens which would cause 1. D. of myopia; and by subtracting 1. D. from its strength the hyperopia of the eye is obtained.

For example: Suppose hyperopia of 4. D. The light in the pupil will move against the light on the face at the first inspection, and also with the convex 2. D. and 4 D. lenses. With the convex 6. D. it is found to move with the light on the face. On trying the convex 5. D., the movement is indeterminable. With the 4.75 D., it is very rapid, but still against the light on the face. With the 5.25. D., it is equally rapid, but with the light on the face. The lens strength between the two, or the 5. D., is then the one which causes 1. D. of myopia; and 5. D., the strength of, minus 1. D., the myopia caused by it, leaves 4. D., the lens strength required to correct the hyperopia present.

Myopia. In the mass of cases the inspection without a lens will show the movement of light in the pupil with the movement of light on the face, indicating the point of reversal is between the surgeon and the patient. When this is the case, concave lenses are to be tried, their strength being indicated by the rate of movement; or, if this be not a sufficient guide, they may be tried in series with an interval of about 2. D., until one is found which causes the light in the pupil to move against the light on the face.

As the point of reversal is thus brought farther from the eye of the patient and nearer to the observer's eye, the light area in the pupil becomes more brilliant, and its movement more rapid. When the lens has been found which causes the light in the pupil to move against the light on the face, slightly weaker lenses are to be tried until it has been ascertained which is the weakest lens that will cause the

movement against that of the light on the face, and which is the strongest lens that still allows movement in the pupil with the light on the face. Between these two lies the lens-strength which leaves the eye 1. D. myopic. This lens-strength added to 1. D. will give the total myopia present.

For example: Suppose the myopia present to be 8.5 D. The movement in the pupil without any lens will be very slow, and the light areas round and dim. Judging from this appearance the first lens tried may be the concave 5. D. With it, the light in the pupil will appear more brilliant and its movement will be more rapid, but it will still be with the movement of the light on the face. Next, the concave 8. D. will be tried. The movement of light will be found still more rapid, but now against that of the light on the face. With the concave 7. D., it will be found equally rapid, but with the light on the face. With the 7.5. D. it will not be distinguishable. Hence, the 7.5. D. lens leaves 1. D. of myopia still uncorrected, and this added to the 7.5 D. corrected by the lens gives 8.5 D., the total myopia present.

If the myopia be of low degree, the test without a lens will show either no distinguishable movement of light in the pupil [for myopia of 1. D.], or movement in the pupil against the movement of light on the face [for myopia of less than 1 D.]. In the former case the test is to be repeated with very weak convex and concave lenses [0.25. D. or 0.50. D]. The convex will give a movement of the light in the pupil with the light on the face, and the concave movement against the light on the face.

If the movement is found to be against the light on the face to start with, the convex lenses are to be tried, commencing with a 1. D. lens, which will cause the movement with the light on the face, and will show, therefore, that the refraction is myopia and not emmetropia, or low hyperopia. The weaker lenses are then to be tried, and the one which causes 1. D. of myopia thus ascertained. Since this lens is added to the myopia of the eye to cause 1. D. of myopia, it must be subtracted from 1. D. to find the amount of myopia originally in the eye; the difference between it and 1. D. being the myopia present.

Thus, in a case of myopia of 0.50. D. the light will be found to move against the light on the face, without any lens, or with a 0.25. D. convex. But will be found to move with the light on the face, with a convex 1. D., or 0.75. D.; and with an 0.50. D., the movement should be indistinguishable. The convex 0.50. D. then causes 1. D. of myopia, and subtracting it from 1. D. leaves 0.50. D., the degree of myopia previously existing in the eye.

Emmetropia with the concave mirror. In emmetropia, on the first

trial, the light in the pupil is found to move rapidly against the light on the face. With convex lenses it is found that the 0.75 D., or anything weaker, still allows this movement against the mirror. But the 1.25 D., or anything stronger, causes motion in the pupil with the light on the face; and the convex 1. D. causes no perceptible movement. Hence, the convex 1. D. lens causing 1. D. of myopia, the eye without a lens must be emmetropic.

Regular astigmatism with the concave mirror. The test begins as for simple hyperopia or myopia. As the point of reversal for one of the principal meridians is brought near the observer's eye the movement of light becomes notably more rapid in one meridian than in the other, indicating the presence of this form of ametropia. When this is recognized, the lenses used are to be such as give a movement of light in the pupil with the light on the face in all meridians. Thus, if the eye has been hyperopic, the convex lenses used before the eye must be increased in strength until the movement with the light on the face occurs in all directions. Or, if the eye is myopic, the increase of strength in the concave lenses must stop so soon as any movement is seen in the pupil against the movement of light on the face. And the lens which causes this must be replaced by a weaker one that just allows movement with the light on the face in all meridians.

The lens aimed at is the one which will bring the point of reversal for the last myopic meridian just to the surgeon's eye, one metre from the patient. If this is exactly attained, there will be in that meridian no perceptible movement of light and shadow, but the movement in the other principal meridian will still be with that of the light on the face.

When this lens has been found, the *original source* of light is to be brought closer to the mirror, so that the image of it formed at the conjugate focus in front of the mirror—the *immediate source* of light—will be removed farther from the mirror and closer to the patient's eye.

The lens before the patient's eye brings the point of reversal for the least myopic meridian to the eye of the surgeon, and necessarily places the point of reversal for the more myopic meridian somewhere between the surgeon and patient. The object of bringing the *original* source of light nearer to the mirror is to carry the *immediate* source of light to the point of reversal for this more myopic meridian. As the light approaches its proper position, the area of light in the pupil becomes more and more band-like, being most distinctly so when the immediate source of light corresponds with the point of reversal for the more myopic meridian.

When this is attained, the direction of the band is to be carefully noted as indicating the direction of the principal meridian of least myopia. This direction having been determined and recorded, the original source of light is again moved away from the mirror, and measurement of the refraction in the least myopic meridian completed as for a case of simple myopia or hyperopia.

Then, the lenses are so changed as to bring the point of reversal for the more myopic meridian to eye, one metre from the patient. The lens that is found to do this, shows by the addition of 1. D. if concave, or the subtraction of 1. D. from the strength if convex, the amount of myopia or hyperopia in the second meridian. The difference between the two meridians is the amount of astigmatism.

The cylindrical lens correcting the astigmatism is to be placed before the eye with the spheric lens which will bring the point of reversal to a distance of one metre. The trial is then repeated as explained for the plane mirror.

Aberration and irregular astigmatism with the concave mirror. With the concave mirror, and the need of bringing the point of reversal to a fixed distance from the patient's eye, the measurement of the amount of aberration and irregular astigmatism is more tedious and difficult than with the plane mirror. It is, however, not difficult to detect the presence of such defects; and to ascertain which portion of the pupil they occupy, and which portions being comparatively free from them are available as a visual zone. The importance of such a study of the pupil, has been dwelt upon in the section on the plane mirror.

Measurement of accommodation with the concave mirror. With the aid of lenses, usually concaves, the near point of accommodation may be brought to the required distance of one metre from the eye, and the amount of accommodation thus measured. The arrangement of the patient's and surgeon's eyes, and of the points to be looked at, is the same as that described in connection with the measurement of accommodation with the plane mirror. It is, of course, impossible to make the approximate determination of the accommodation with the concave mirror by the surgeon approaching the eye of the patient. He must rely entirely on changes of lenses to bring the point of reversal to the fixed distance of one metre.

Value of skiascopy with the concave mirror. On the whole the advantages of the plane mirror greatly outweigh those of the concave; but in certain respects the latter may be found superior. When the surgeon is without his usual facilities, and is compelled to make the examination with an unshaded light, the concave mirror is less handicapped by this unfavorable condition.

In astigmatism, the concave mirror fixes with greater accuracy the meridian of least refraction (axis for concave cylinder). In positive aberration, the retinal light area is most sharply outlined, when the immediate source of light is closer to the eye than the point of reversal, as it is with the concave mirror.

SKIASCOPY APPARATUS.

The mirror. The essential point in the mirror is the sight hole. This should be small enough and free from reflections.

If the sight hole is not cut through the glass, but is merely an aperture in the silvering, the glass may be much thicker and there is no ground glass to deal with. The difficulty with such a mirror is in keeping the exposed glass at the sight hole clean. Unless great care is taken in preserving it from dust, and carefully removing any that falls upon it, there will be a ring of dust in the periphery of the sight hole, which will irregularly reflect more light than would the ground glass of the perforated sight hole. And, it is difficult to keep this space entirely clean without chipping into the back of the mirror in such a way as to cause annoying reflections. But, however difficult, it is important to have the sight hole free from reflections.

Crampton (*Transactions of the College of Physicians of Philadelphia,* 1915, p. 391) has described the plan of protecting the sight hole when the glass is not cut out, but only the silvering scraped away, by cementing over it a very thin disc of glass on the back of the mirror with Canada balsam. By leaving an opening 7 mm. in diameter in the metal back of the mirror the sight hole can be readily kept clear.

The size of the mirror will depend somewhat upon the purpose for which skiascopy is to be used. If the mirror is to be employed to measure refraction of all kinds, to show the movement of light in the pupil with high uncorrected hyperopia or myopia, it must be large, to give the range of movement for the immediate source of light that is necessary to render evident the direction of movement in the pupil, when that movement is slow and the illumination of the area is comparatively feeble.

The disadvantage of a large mirror is that it gives a large area of light on the face, especially when as with the plane mirror, the original source of light is brought close to it. And in this large area of light on the face only the light reflected by a small portion of the mirror immediately surrounding the sight hole is of any use when the point of reversal is near to the surgeon's eye. With a small mirror, making a small area of light on the face, it is easier to keep this upon the

eye than it is to keep the similar limited portion of a large area properly directed.

On this account, where skiascopy is used, after an approximate estimate of the refraction has been made by the ophthalmoscope or other means, quite a small mirror is found convenient. By a large mirror is meant one from 35 to 50 mm. in diameter. By a small mirror is meant one under 20 mm. in diameter. The mirror, or, at least, the opaque back that carries it, cannot be well reduced to less than 20 or 25 mm., because, if smaller than this, it will admit light to the eye from the original source.

A mirror that can be used of full size or stopped down to 10 mm. in diameter is shown in Fig. 24. A compromise mirror devised by J. Thorington (*Philadelphia Polyclinc*, 1893, p. 329) has been very widely used. It is 2 c. m. in diameter. As already indicated, the sight hole should be about 2 mm. in diameter.

The shade in skiascopy. The shade that covers the original source of light should extend far enough above and below the flame to prevent the escape of any considerable amount of light into the room. An asbestos shade has been proposed by J. Thorington (*Ann. of Ophthalmology and Otology*, 1895, p. 5) on account of intercepting better the heat of the flame.

A single metal chimney surrounding the glass or mica chimney does much to moderate the heat. But it can be still further diminished by using a double metal chimney, the two cylinders of which are separated by an air space of 5 mm. or more. The inner of the cylinders may have a large opening, such as may be used for ophthalmoscopy. The outer cylinder must also have smaller openings, one of which will give the required source of light. These openings are placed at the same height, opposite the brightest part of the flame, so far apart that only one of them is before the large opening in the inner cylinder, at any one time, and the outer cylinder can revolve on the inner, so that any desired opening can be brought in front of the light. The diameter of the opening must be inversely proportioned to the skill and experience of the observer.

The aperture of 5 to 10 mm. diameter for the plane mirror, or larger, for the concave mirror, should be opposite the brightest part of the flame.

The lenses for skiascopy. Ordinarily these are taken from the trial case and placed in a trial frame before the eye. It is important to have them clean and comparatively undamaged by scratching. The trial frame should be such as to support the lenses well up before the eye and with their centres before the centres of the pupils. They

must also be far enough away from the face to escape the touching of the lashes, and to prevent the condensation of moisture upon them. The interruption of the red reflex from the pupil by such an occurrence prevents the satisfactory application of the test, and may be quite puzzling, because the reason for the obscuration is not immediately apparent.

Support of lenses. The trial frames have the advantage over other supports for lenses to be presently mentioned, that they keep a constant position with reference to the patient, so that a slight movement of the patient's head does not carry his eye away from the centre of the lens to its periphery or beyond.

When the surgeon has learned to estimate by the rapidity of movement of the light in the pupil, the amount of ametropia remaining uncorrected, by following the plan here laid down of considerable intervals between the lenses until an approximation of the required lens has been made, the number of changes of lens for any case is not necessarily great.

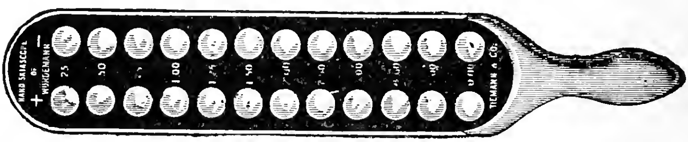


Fig. 24. Würdemann's Hand Skiascope.

Special series of lenses mounted in revolving disks have been arranged by Haines (*Ophthalmic Review*, 1886, p. 282), Burnett (*Trans. Am. Ophthalmol. Soc.*, 1888, p. 223), Doyne, Couper, Würdemann, and others, to save time by facilitating the changes to the lens required. Some of these have been designed for the patient to make the change of lens under the direction of the surgeon, and others to give the surgeon himself control of their movements.

One of the simplest arrangements is that described by Würdemann (*American Journal of Ophthalmology*, 1891, page 223), shown in figure 24. The lenses are inserted in a sheet of hard rubber which the patient holds by the handle, bringing before his eye the lens the surgeon may indicate. Crouch and Clapp (*Amer. Jour. Ophth.*, 1914, vol. 31, p. 38) modified the Würdemann instrument, diminishing the interval between the lenses to 0.25 D., and extending the series to 14 D. plus and minus. The writer, using habitually the plane mirror, has discarded all special forms of apparatus, and depends on the trial frame and test lenses.

Meridian indicators. In working with lenses in the graduated trial frame one may refer to its graduation to ascertain the direction of the bands of astigmatism. But in the darkened room this is not convenient. To meet this want, Thorington (*Medical News,* March 3, 1894) and Prince (*Ophthalmic Review,* July, 1894) have suggested disks specially graduated for the purpose; the former called an axonometer; the latter an inclinometer. Better than either of these is the disc shown in Figure 25.

The wire stretched across is made to conform with the direction of the band of light; and the graduation, visible in the dark room, gives approximately that direction without moving the frame from the face. A more elaborate apparatus has been described by Starke (*Centralbl. f. p. Augenheilk.,* 1909, p. 260).

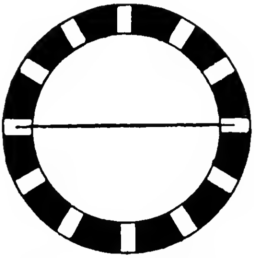


Fig. 25. Skiascopy.
Meridian Indicator of Finch.

A distance measure in skiascopy. Where the concave mirror is employed, the distance remaining fixed throughout the test, it is only necessary that the surgeon should properly place himself at the beginning, and retain his position. He can then dismiss the consideration of the distance, or provide for it by the addition of 1. D. to the concave spherical lens or the subtraction of 1. D. from the convex spherical lens that brings the point of reversal to his eye.

With the plane mirror no measure is necessary where the test is used only to approximate the refraction, the surgeon soon learning to guess at the distance closely enough to be within 0.25. D. of the amount of myopia present with the lens fixed upon. But for exact measurement it is convenient to have something to measure from the patient's eye to the surgeon's. This may be either a tape attached to the trial frame or lens disk (Burnett), or to the handle of the mirror and picked up and held to the eye when the test is completed; or it may be the ordinary metre stick. In either case, it is convenient

to have the measure graduated in dioptric focal lengths, as described by the writer in the *Medical News,* June 27, 1885.

Electric light skiascope. An instrument using, as the source of light a small incandescent lamp, fixed in a tube attached to the mirror, was presented by H. Wolff at the meeting of the Heidelberg Ophthalmological Congress in 1896; and a somewhat similar instrument has been made in this country by De Zeng. These lamps give approximately a point of light, which may be a better source of light than is usually obtainable outside of the room especially fitted up for skiascopy.

Other instruments for skiascopy combining a special source of light and series of lenses, have been devised. They may assist the beginner, but are not adaptable to all conditions, and do not favor the highest exactness.

EXACT SKIASCOPY.

The procedures necessary to render skiascopy most exact cannot well be carried out until the test is thoroughly understood, and somewhat familiar in practice, and it is only when taken together that these procedures are of value. A small source of light cannot be used without a small sight-hole in the mirror. A small sight-hole in the mirror adds to exactness only as it allows the use of a small source of light. A short distance between surgeon and patient, demands accurate measurement of that distance. Accurate measurement of the distance is unnecessary except when the distance is short. Aberration and irregular astigmatism cannot be so well studied with the concave mirror; and it is largely by excluding the errors they cause that skiascopy is rendered exact.

Exact skiascopy is only possible in a dark room, and the darker the room the more easily is it practised. The observer's retina must be adapted to such work by the temporary exclusion of light. Looking directly at the source of light, will disable the eye for exact skiascopy for some minutes. If the light needs adjustment, this should be effected without looking directly at it. Or it may be looked at with the other eye, the one employed for the test being screened from it.

For many eyes exact skiascopy is impossible at a distance of more than one-half meter. Certainty, accuracy, and ease in recognizing the form of the most important light area and its movements, require that the distance be short.

Size of the pupil in skiascopy. The accuracy of skiascopy depends on the approximation of the retinal light area, to a mathematical

point or line. The reduction of the opening in the metal chimney, reducing the original source of light and the accurate focussing of the immediate source of light on the retina, by bringing it as close as possible to the point of reversal are to secure this close approximation. But such approximation is interfered with by aberration and irregular astigmatism.

In most eyes these optical defects are present chiefly in the periphery of the pupil, and their interference with the focussing of the retinal light area, can be prevented by contracting the pupil and shutting off this defective peripheral area. Even when such defects encroach upon the central or visual zone of the pupil, their effect can be reduced to the minimum, by reducing the pupillary aperture.

Hence in many eyes, certain points can be better determined by skiascopy with a small pupil. To determine these the test should be applied before the use of a mydriatic. If the mere darkening of the room causes too much dilatation of the pupil, as it may do in young eyes, the pupil can be contracted by having the patient accom-

Fig. 26. Pupil Stop for Skiascopy.

modate for a comparatively near point. Thus, if the observer is one-quarter metre from the patient, the focussing of the observed eye upon the upper edge of the mirror, will be attended by a very noticeable contraction of the pupil. Extreme contraction is not to be desired since skiascopy is very difficult with the pupil less than four millimeters in diameter.

The important points to determine by skiascopy, without a mydriatic, are the direction of the principal meridians, and the amount of astigmatism. Measurements so made may differ from those made with the eye under a cycloplegic, but often they do not. If they do, having both sets of data before him, the surgeon will be less likely to fall into error, than if he depended upon only one.

When a cycloplegic has been used, or when the darkening of the room produces too great dilatation of the pupil, it is still possible to diminish the influence of irregular astigmatism and aberration, by the use of the pupil stop or shield. A double stop of this kind is shown in Fig. 27.

At each end is a disc, 10 mm. in diameter. Each disc contains a central opening, one 5 mm., the other 6 mm. in diameter. One of

these is held in front of the pupil, so that the outer margin of the disc is just within the margin of the cornea. The bright point of corneal reflex may be taken as a guide to ensure that the opening exposes the central or visual zone of the pupil. Such a stop is not often necessary, but will occasionally be of assistance. It should be held as close to the patient's eye as possible, the hand being steadied by the fingers against the patient's brow. Mason (*Ophthalmic Record,* Vol. 21, p. 665) arranged an opaque metal disk which fitted in the trial frame, supplied with diaphragms by which the opening could be varied from 2 to 8 mm. in diameter.

Fixing the meridians of astigmatism in skiascopy. This is the first and most important point in the measurement of astigmatism by skiascopy. When the astigmatism is of sufficiently high degree to give a decided band of light (0.5 D. or upward) the direction of its principal meridians can be fixed most accurately by the method already described.

Sometimes, however, the direction of the meridians can be fixed more accurately by a cylinder that increases the astigmatism, instead of correcting it. Thus, if the required correcting lens were convex 0.25 D. cylindrical with its axis at 90°, one might use instead, a concave 0.25 D. cyl., with its axis at 90°. This would give the appearance of 0.50 D. of astigmatism, causing a distinct band, the direction of which could be accurately determined.

If the direction of this band is that of the axis of the cylinder the cylinder has been so placed that its axis corresponds with one of the principal meridians. If, however, the direction of the band obtained does not correspond with the axis of the cylinder, that axis has not been placed in the direction of the principal meridian. But the band will lie half way between the present position of the axis and the real position of the meridian sought. If when the axis was placed at 110°, the band should appear in the direction of 90°, the real direction of the meridian would be 100°.

To make sure that an accurate determination of the refraction has been made by skiascopy, it is necessary not only to find the lens which seems to correct the refraction; but to go beyond this far enough to demonstrate that any stronger lens would be an over-correction. This plan of approaching the correction from both sides, is of value in all methods of measuring errors of refraction. But it is of especial importance in skiascopy.

Exact skiascopy is only possible after much practice with care to work out the correct result in each case because all eyes present aberration and irregular astigmatism, which cause forms and movements

of the light areas, that it is impossible to describe and classify. These variations can only be understood by understanding the underlying theory of the test.

The exactness attainable by this method of estimating the refraction of the eye is sufficient for practical purposes. Newcomb (*Amer. Jour. Ophth.* v. 2 p. 226) believes that proper application of skiascopy furnishes the ideal method of determining errors of refraction, and has found it superior in every respect to subjective methods. No other method is so worthy of being used alone, or having sole dependence placed upon it. Still to diminish the risk of error, which attends all measurements we make, the results of skiascopy should, as far as practicable, be checked by independent methods, especially by the best forms of subjective tests.

AUTO-SKIASCOPY.

The surgeon can apply skiascopy to the measurement of his own refraction, by the use of an ordinary looking-glass, in addition to the apparatus commonly employed for the test. He simply practises skiascopy on the reflected image of his own eye, as he would on the eye of the patient. The glass in which his eye is reflected, will be spoken of as the "looking-glass" to distinguish it from the "mirror," which is used as in ordinary skiascopy.

One eye (the observing eye) is used to study the refraction of the other (the observed eye). Thus the right eye is used to test the left, and the left eye to test the right. Double the distance from the eyes to the "looking-glass," corresponds to the distance between surgeon and patient in ordinary skiascopy. If a variable distance is used, as with the plane mirror, the surgeon measures his distance from the "looking-glass" and doubles it. If he wishes to work at a fixed distance, as one metre, he simply places himself at half that distance from the "looking-glass."

For the plane mirror the light, properly shaded, is brought close to the surgeon's eye, as for ordinary skiascopy. It is best placed on the side of the observing eye; and may well be so much to the side as to be shut off from the observed eye by the bridge of the nose. For the concave mirror the source of light should be some distance behind the "looking-glass," sufficiently to the side of the observing eye to shine upon it, but not far enough to the side to shine on the observed eye, which must be kept as much as possible in the shadow. With the electric light skiascope the test is applied as with the plane mirror.

First, when the test is resorted to with the plane mirror, the light-

source close to it sends light to the mirror which the surgeon holds to the observing eye. From the mirror the light is reflected to the "looking-glass," from which it is reflected to the observed eye, and forms in it a light area on the retina. From this light area the light emerges, and striking the "looking-glass" is reflected to the observing eye, through the sight hole in the mirror. The apparent movement of the light area within the pupil is as it would be observed in the pupil of a patient, placed at the apparent position of the image formed by reflection behind the looking-glass. The movements of the light area are produced by the same movements of the mirror as in ordinary skiascopy; and the apparent movements in the pupil have the same direction and significance as in the pupil of the patient.

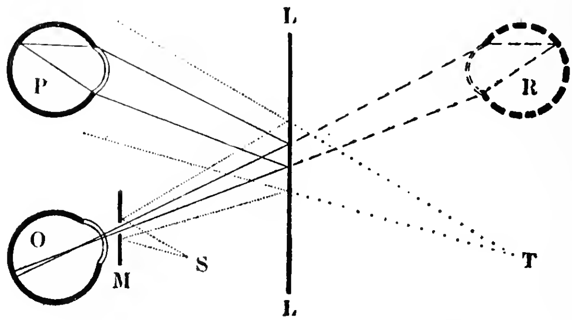


Fig. 27. Course of Rays in Autoskiascopy.

O. Observing eye, P. observed eye, R. image of observed eye formed by reflection, M. mirror, L. looking-glass, S. source of light, T. virtual image of source of light from which rays enter the observed eye. The dotted lines show the course of the rays from the source of light reflected by the mirror and looking-glass to enter the observed eye. The solid lines represent the course of the rays emerging from the observed eye, reflected from the looking-glass and passing through the hole in the mirror to enter the observing eye.

With the plane mirror it is easier to change the distance of the observing eye from the observed eye than in ordinary skiascopy, every inch of change in the position of the surgeon making two inches difference in the distance from the observer to the reflected image. In moving the light away from the mirror to bring out more distinctly the band-like appearance showing the principal meridians of astigmatism, the distance that the light is moved is not duplicated by reflection, but the interval between the light and the observing eye is simply added to twice the distance of the eye to the "looking-glass" to get the distance of the source of light from the observed eye.

With the concave mirror, to get the source of light in the same relative position as when placed behind the patient's head, in the ordi-

nary testing of a patient, it is necessary to place it farther behind the "looking-glass" than the apparent situation of the reflected image. It should be at least one metre or more behind the looking-glass, except when to bring out most accurately the meridians of astigmatism it is brought closer to the mirror. With the concave mirror, as with the plane mirror, the direction and the significance of the movements of light and shadow in the pupil are the same as in ordinary skiascopy.

Auto-skiascopy is from the first almost as easy as applying the test to the eyes of another. The double part of observer and observed, each eye taking a different role, is at first somewhat puzzling, but when one has become accustomed to it, it rather facilitates the test. The observed eye, fixed on the "looking-glass," is conscious of the movement of the source of light reflected in the mirror in front of the observing eye. At first there is an inclination to fix upon this bright light. But, when one has learned to overcome this inclination, the consciousness of the light may be utilized to help to bring the light area properly upon the observed eye.

When watching by reflection the movements of light and shadow in one's own pupil, the fixation of the observing eye (and the observed eye also) is upon the reflected image of the pupil of the observed eye. The observed eye under these circumstances has its line of sight exactly perpendicular to the mirror, and were that part illuminated would be in position to see the reflection of its own fovea centralis. But the light is not reflected from the observed eye. It comes from the direction of the observing eye, and therefore, falls upon the retina of the observed eye to the temporal side of the fovea, illuminating this part of the retina, from which the light reflex returns to the observing eye. By auto-skiascopy, therefore, one measures not the refraction at the fovea, nor yet the refraction toward the disc, but the refraction of a point of the retina somewhat to the temporal side of the fovea.

The chief value of auto-skiascopy will be found in the opportunity it gives for practice with the test. For isolated students this advantage is important, for skiascopy requires a great deal of practice to develop its full possibilities.—(E. J.)

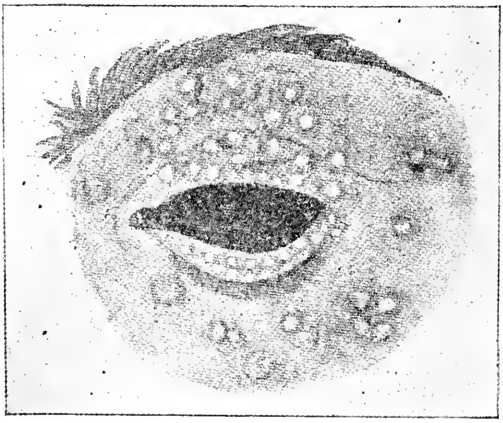
See, also, **Skiascope**; **Skiametry, Dynamic**; **Scissors movement**; **Physiological optics**; as well as p. 4718, Vol. VI of this *Encyclopedia*.

Skin diseases, Ocular relations of. Although under several **Eyelids** rubrics; under **Dermatitis**, p. 3834, Vol. V; **Exudative erythema**, p. 4785, Vol. VI; **Cornea, Acne of the**, p. 3331, Vol. V; **Dermal diseases**, p. 3832, Vol. V; **Conjunctivitis with skin diseases**, p. 3177, Vol. V, and similar captions of this *Encyclopedia* treating the various affec-

tions of the skin that present ophthalmic symptoms, this subject has to a large extent been discussed, some further observations may be added here.

Rothmund observed seven children with a peculiar fatty degeneration of the dermal papillæ and stratum Malpighii with secondary atrophy, that appeared during infancy. Of these five had cataract at the ages of three to six years.

N. T. Andogsky (*Viestn. Oft.*, Dec., 1913; abstract *Oph. Review*, p. 216, July, 1914) has had under his observation the following four cases of *soft cataract associated with extensive skin disease*. 1. A woman of 32, affected with high myopia from childhood, developed erythema exudativum multiforme all over the body. She had also



Varioloid of the Eyelids. (Von Ammon.)
The patient had suffered a previous enucleation.

suffered previously from extensive furunculosis. Shortly after, broad rays of opacity appeared in the anterior layers of the lens. Vision in the right eye with a —10 D. sph. was 3/70, and in the left with the same correction 1/70. Discission followed by linear extraction with subsequent needling of the capsule gave vision 0.9 in the right eye with a + 5 D. sph. and 1 in the left with a + 6 D. sph. The fundus showed only a small crescent.

2. A man of 27, who gave a history of recurrent prurigo, eczema and pustular eruptions over the whole body with cervical lymphadenitis, had on both sides an anterior stellate cataract. The urine contained 0.1 per cent. of albumen, together with some granular and hyaline casts and an increased amount of urates. Two years later the then almost mature cataract was extracted with a visual result of 0.9.

3. A woman of 24, affected since the age of ten with eczema of the face, scalp and trunk, with occasional exacerbations accompanied by extensive furunculosis. The condition of the lenses was similar to that in the last case, the vision in the right eye being 0.1, and that in the left 0.2.

4. A man of 42, covered with eczema, with an anterior stellate cataract.

Comparing these cases with those recorded by Rothmund, Mooren, Förster, Nieden and Werner, the writer sums up the clinical picture of dermogenetic cataract as follows.

The dermogenetic cataract is one developing in early life, from the tenth decade till over thirty, in association with extensive skin disease in the shape of inflammations, atrophies or angiopathies. The opacity generally begins in the anterior layers of the lens in the form of stellate cataract or of triangular sectors with the base at the equator. These seem to depend on disturbance of the capsular epithelium. These cataracts become mature with very varying rapidity, six to eight days in very young people, one to two years in adults. They are not accompanied by any fundus change and the prognosis after successful operation is good.

The author explains the connection between the cataract and skin affection partly, as do Rothmund and Werner on the ground of embryonic affinities, but also, and with greater probability, as connected with some form of autointoxication the result of the disturbance of the normal skin function.

Skin-grafting. Skin transplantation. Plastics. This subject has already been rather fully discussed under **Blepharoplasty,** p. 1040, Vol. II; **Entropion,** p. 4331, Vol. VI; **Grafting,** p. 5628, Vol. VII, and under the other captions listed on p. 10255, Vol. XIII, of this *Encyclopedia.* Further references to the recommendations in this connection of Kuhnt and of Walter Parker have recently appeared in the *Ophthalmoscope,* and these are repeated here.

Kuhnt (*Zeitschr. für Augenheilk.,* Jan., 1915) again recommends that in cases of shrunken conjunctival sacs after chronic trachoma, or after burns and cauterization, or when the eye has been excised, that a large Thiersch skin-graft should be employed, because this procedure often enables an artificial eye to be worn. Further experience has convinced him of the value of this procedure. It produces a permanent effect, although naturally the graft shrinks somewhat. The periphery of the graft must be tucked some millimetres under the retracted conjunctiva, and it must be gently pressed into the orbital tissue by an appropriate plug of gauze.

The method is equally useful if the eye be not excised but eviscerated, with or without the insertion of a piece of fat or charred bone into the scleral sac. It is, however, necessary in the latter case so to tie the sutures that the knot lies inside the globe, and not outside. If the knot lies outside, the graft necroses over it, and a large central piece may slough. Kuhnt says that the movement of an artificial eye placed over an eviscerated globe is markedly better than after enucleation, especially if the tendons of the recti be sewn to the conjunctival sac, and are so prevented from retracting excessively. The result is even better if the sclera be filled with fat or with a ball of charred bone, only it must not be too large.

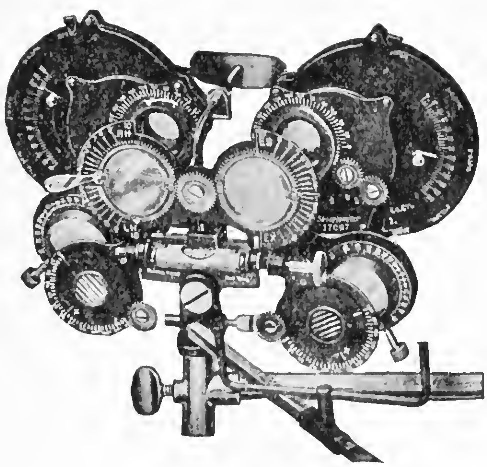
Walter Parker (*Ophthalmic Record*, March, 1916) in a brief and modest communication, gives most careful information with regard to the technique of skin-grafting, based upon the author's experience in correcting defects in and about the eyelids with Thiersch grafts.

After preparing the skin to be grafted in the usual way, Parker suggests that skin and blade be thinly smeared with sterile vaseline, inasmuch as in that way the tendency of the skin to move with the knife (one of the greatest difficulties in the successful cutting of grafts) is done away with. He has adopted this plan in twelve operations, where the grafts varied in length from 12 mm. to 50 mm. The vaseline interfered with the healing process in not a single case. Stress is laid upon checking all bleeding from the surface to be repaired before applying the graft. It is better to remove the grafts and delay until the surface is free from blood, even if that takes several hours, than to attempt to adjust the graft whilst oozing is taking place. The vitality of the graft is such that a short delay does no harm, but should this extend to several hours, and the grafts are small, fresh ones may be cut. Once in place, the graft should be disturbed as little as possible. If several grafts are required, they should be so arranged as to overlap one another slightly, as well as the skin margin. There must be no tension. Nothing, in his experience, delays the immediate result more than to leave small denuded areas between the grafts or at the margin of the skin. Over-correction of the defect should always be aimed at. As to dressing, Parker is a strong advocate of the "open-air method"—that is to say, he covers the grafted area with a suitably shaped plate of aluminum, freely perforated. The parts are dusted with aristol, and the aluminum shield is covered with gauze and held in place by strips of adhesive plaster. This method of dressing has been adopted by Parker in forty-two operations.

Skin reflex. Cutaneous excitation test. Cutaneous stimulation test. See **Cutaneous excitation test,** p. 3603, Vol. V of this *Encyclopedia.*

Skin vision. See **Blind, Sixth sense of the,** p. 1202, Vol. II of this *Encyclopedia.*

Ski-optometer. A patented instrument eliminating the consecutive transferring of spherical, cylindrical, and prismatic lenses; used for both the objective and subjective determination of the refraction, and in ocular muscle testing.



Ski-optometer.

Skotogram. Skotograph. See **Scotogram, Scotograph.**

Skotoscopy. A synonym of skiascopy (q. v.).

Skull, Ophthalmic relations of the. The skull (the study of which is called craniology) is divided into two parts, the cranium and the face. In human anatomy it is customary to describe the former as consisting of eight and the latter of fourteen bones; the eight cranial bones, which constitute the brain-case, being the occipital, two parietal, two temporal, sphenoid, and ethmoid; while the fourteen facial bones, which surround the cavities of the mouth and nose and complete the orbits or cavities for the eyes, are the two nasal, two superior maxillary, two lachrymal, two malar, two palate, two inferior turbinated, vomer and inferior maxillary. The lower jaw articulates with the temporal bones by means of a diarthrodial joint, but all the others are joined by sutures. On the base of the cranium the occipital and sphenoid bones articulate by means of a plate of cartilage in young subjects; in adults this becomes bony union. Sutures are named from the bones between which they are found, but to those around the parietal bones special names are given, e. g., interparietal or sagittal;

occipito-parietal or lambdoid; fronto-parietal or squamous. During adult life many of the sutures close by bony union and disappear, but both the age at which this occurs and the order of its occurrence are subject to variation. Irregular forms may be produced artificially by pressure applied early in life. This is best seen among certain American tribes who compress their children's heads by means of boards and bandages. The bones of the skull are pierced by holes (foramina), and similar holes are found in relation to the adjacent margins of bones. Compared with the skulls of animals, the form of the human skull is modified (1) by the proportionately large size of the brain and the consequent expansion of the bones which surround it; (2) by the smaller size of the face, especially of the jaws, so that the face of the man, instead of projecting in front of, is *under* the forepart of the cranium; (3) by the erect attitude, which places the base of the skull at a considerable angle with the vertebral column, and, in consequence of a development backwards from its point of articulation with the vertebra, the skull is nearly balanced on the summit of the vertebral column. Hence the orbits look forwards and the nostrils look downwards.

Race. In comparing the skulls of different races of mankind it is necessary to have recourse to various methods of measurement (craniometry), and these are usually conducted on the skulls of adult males. The following is a short summary of these methods. (a) *cranial capacity*—This is obtained by filling the cranial cavity with shot, and then measuring the quantity in a graduated vessel, special precautions being observed in order to obtain equable results. The capacity of normal human crania varies from 60 to 110 cu. in.—the average in all races being 85 cu. in.—e. g., Eskimo, 91.5; European, 90.3; Chinese and Mongols, 87.3; African Negroes, 82.4; Native Australians (aboriginal), 79.3; Andaman Islanders, 78.1. (b) Linear measurement of the *horizontal circumference* of the cranium. In the adult European male the average is 20.7 in. and in the female 19.6 in. (c) A third method is by comparison of the relative *length, breadth* and *height* of the cranium. The standard of maximum length is taken as 100, and thus 100 x breadth ÷ length = *index of breadth* or *cephalic index;* and on this basis skulls are classified in three groups—viz.: Brachycephalic = breadth-index above 80. Mesaticephalic = breadth-index from 75 to 80. Dolichocephalic = breadth-index below 75.

In a similar way the proportion of height to length may be calculated, and a *height-index* established. It varies less than the breadth-index—e. g.:

	Breadth	Height
Mongolians of Siberia and Central Asia	88	73
Andaman Islanders	82	77
Chinese	79	75
English	76	71
Native Australians (aboriginal)	71	71
Fiji Islanders	66	74

A time-honored measurement, long thought to be sufficient in itself for founding a classification of races, was the facial angle of the Dutch anatomist Peter Camper. This was obtained by drawing one line from the center of the forehead to the most projecting part of the upper jaw just above the incisor teeth, and another from the opening of the ear to the base of the nasal opening; between these was contained the facial angle.—(*Standard Encyclopedia.*) See, also, p. 3553, Vol. V, as well as **Race**, and **Ethnology of the eye,** p. 4535, Vol. VI; also **Tower skull** and **Oxycephaly** of this *Encyclopedia.*

Skull bones. The bones of the skull, burnt and pulverized, were highly esteemed by Pliny the elder (XXVIII, 11) as a depilatory in trichiasis.—(T. H. S.)

Skull, Fracture of the, Eye signs of. See **Injuries of the eye**; as well as **Military surgery of the eye.**

The ophthalmic signs of cephalic injury vary much according to the region of the trauma and the parts involved.

Fractures of the base of the skull. These include the nerves having their exit at the injured parts. They include paralysis of muscles, especially of the rectus externus, paresthesiæ, perimetric defects, loss of central vision of all degrees. As a rule the ophthalmoscope shows nothing abnormal, even after direct injury of the optic nerve; later we observe the usual signs of an optic neuritis, followed by atrophy.

Skylight illumination. See **School hygiene.**

Slack of the optic nerve. The surplus length of the optic nerve, permitting a certain amount of play of the ball. It averages 5-6/10 millimeters.

Slate, Bissell blind-spot. A copyrighted name given by the proprietors to a device for mapping papillary scotomata. See **Stereoscope.**

Slawikowski, Anton. A Polish physician, who devoted the greater portion of his time to ophthalmology. Born at Lemberg in 1796, he received his medical degree in 1819 at Vienna. In about 1825 he was made extraordinarius in ophthalmology at the Lemberg School of Surgery, a position which he held till 1851. From 1838 till 1851 he was National Oculist to Galicia, as well as ophthalmic surgeon to the Gen-

eral Hospital. In 1851 he was called to the full professorship of ophthalmology at Cracow, a position which he resigned in 1869. He died June 10, 1870.

His chief ophthalmologic writing was in German. Its title ran: "Ueber die Epidemische Contagiöse Augenentzündung in Galizien" (*Osterr. Med. Jahrb.,* 1845).—(T. H. S.)

Sleep is symptomatic of repose in the brain and nervous system. In those who are awake cerebral activity is unceasing. This is attended by wear and tear of the nervous textures, and by the deposition in them of waste products proportionate to the work effected. After a time a sense of fatigue suggestive of repose supervenes that is only relieved by sleep. Sleep is a state in which these processes are reversed. The brain is inactive; consciousness and volition are in abeyance; respiration and pulse are less frequent; the pupils are contracted and the secretions more or less suspended. Expenditure of energy is curtailed to the greatest extent compatible with life. Recuperative processes continue, and predominate over the destructive; the nervous structures are depurated, and potential energy is accumulated. When recuperation is completed awakening occurs, and is accompanied by feelings of invigoration. The cause of sleep is undetermined, but is supposed to depend upon the production of sedative agents during our waking activities, which ultimately clog the higher functions of the brain. It is believed that the brain is comparatively bloodless during normal healthy sleep.

Sleep varies in depth in persons of different ages. It is usually profound in the young, and light in the aged. The depth bears some relation to its duration. Natural sleep varies from time to time during the same night; it is deepest an hour after its onset, when its intensity decreases quickly, then more slowly, and again it becomes more profound a second time after four or five hours.

How long should one sleep? is a question that must be answered generally. No hard and fast law can be laid down; every man must be a rule to himself. In childhood, when the constructive processes of growth involve large expenditure of energy, sleep is long and profound. In youth much sleep is still needed. In middle age, when decay and repair alone require to be balanced, less sleep is required. In old age, when repair is slowly and imperfectly effected, more sleep is desirable. The duration of sleep is also largely influenced by sex, temperament, occupation, habit of sleep, season, climate, etc. Sleep becomes exaggerated in many idiots, and in "hysterical" patients may develop into trance lasting for days or weeks.

Sleeplessness. The effects of curtailed sleep are very marked. The

loss of a single night's sleep is attended by symptoms of enervation; that of several night's sleep, by serious consequences. In many diseases the lack of sleep determines a fatal issue; conversely, sleep often determines recovery.

Sleeplessness may be due to: (a) An undue excitability of the brain, e. g., in prolonged mental overwork or strain, neurasthenia, etc. (b) Severe pain, as in acute inflammatory diseases, neuralgia, etc. (c) Temporary cerebral congestion, following the use of some drugs, alcohol, coffee, tobacco, etc. (d) In diseases of the central nervous system, e. g., in the earlier stage of many forms of insanity, etc.

Hypnotics, narcotics, and sleep-inducing medicines should never be taken except under medical advice. To drug the brain into quiescence without remedying the cause of the cerebral activity will in many cases only aggravate the evil, for they will be complicated by a drug-taking habit. In most instances drugs are best avoided.

In *Plants,* sleep is one of the phenomena of irritability. Light acts on plants as a powerful stimulus, essential to their active and healthful vegetation. When it is withdrawn the flowers of many plants close, and the greater number show a tendency to it, whilst leaves more or less decidedly incline to fold themselves up. The sleep of plants, however, is always nocturnal. The flowers to some open and close at particular hours of the day. Thus, the crocus is a morning flower, and closes soon after mid-day; whilst some flowers expand only in the evening or during the night.—(*Standard Encyclopedia.*) See **Insomnia,** in the *Appendix.*

Sleep, Condition of the eye during. See *supra,* **Legal relations of ophthalmology,** in middle third of article.

Sleep, Ocular tests for the presence of. See *supra,* **Legal relations of ophthalmology,** in middle third of article.

Sleeping-sickness. TRYPANOSOMIASIS. NARCOLEPSY. The name of a malady long endemic on the Congo and the west coast of Africa. It has of late years appeared in Uganda, where it has proved very fatal. It has been ascertained to be due to the presence in the blood of a parasite of the genus *Trypanosoma,* which is communicated by the bite of the fly *Glossina palpates.* The disease is ushered in by chills, fever, headache, pains in the extremities, enlargement of the lymph glands and anemia. Later, the central nervous system (with occasionally pupillary phenomena) is involved. The patient sinks into a lethargic state, becomes tremulous, somnolent, emaciated and generally dies. The disease may last for years but the fatal issue is at hand when nervous symptoms show themselves. See, also, **Trypanosomiasis.**

Sliding flap. van Lint's method of cataract extraction. See p. 1640, Vol. III of this *Encyclopedia*.

Van Lint (*La Presse Med. Belge,* 64, p. 13, 1915) again insists upon the good results he has obtained from his method of operation for cataract; up to the present all his results have been excellent.

Slit-eye. A vulgar name sometimes applied to one suffering from ptosis.

Slit pupil. See p. 2855, Vol. IV of this *Encyclopedia*.

Greeff (*Arch. f. Augen.*, IXXIV, p. 1, 1914) reports five cases, in which the pupils in bright illumination had the forms of vertical, horizontal, or oblique slits, traversing the whole extent or only the middle portion of the iris. In most cases the pupils grew round, just like the slit-shaped pupils of animals in the dark. One case was complicated by hereditary lues, a second one by other malformations of the eye, as ectropium of the uvea, persistent pupillary membrane, microcornea, conus downwards, etc. All patients had more or less regular astigmatism of the cornea, but the axis never corresponded with the direction of the pupil. According to Fehr, who previously examined one of the cases, the same anatomical conditions exist in this malformation which are normal in the cat. The sphincter of the pupil does not form a ring closed in itself, but radiates fibers which are firmly attached to the ciliary margin and are the more notable the more the sphincter contracts. Greeff inclines to this explanation, which would lead to the assumption of atavism in the Darwinian sense. But, then, it would have been observed more frequently in man. Bürstenbinder considers the condition as an atypical coloboma.

Slitting of the canaliculi. See p. 6946, Vol. IX of this *Encyclopedia*.

Sloane, Sir Hans. A London physician and naturalist of the 18th century, who founded the British Museum and wrote a wretched work about an ophthalmic ointment. He was born of Scotch ancestry at Killeleagh, Co. Downs, North Ireland, April 16, 1660. He studied at Dublin, Paris and Montpellier, at last receiving his medical degree at the University of Orange. He became Sydenham's first assistant and a Fellow of the Royal Society. His ophthalmologic writing was entitled *"An Account of a Most Efficacious Medicine for Soreness, Weakness and Several Other Distempers of the Eye"* (London, 1745). This "efficacious medicine" consisted of viper-fat, aloes, oxide of zinc, and hematite. Sloane died Jan. 11, 1753, aged 92.—(T. H. S.)

The *Standard Encyclopedia* also says of Sloane that his apprenticeship to Stafforth, and his friendship with Boyle and Ray did much to advance him in his studies. He spent over a year (1685-86) in Jamaica, collecting a herbarium of 800 species; and after his return

became physician to Christ's Hospital (1694-1724), secretary to the Royal Society (1693), and Sir Isaac Newton's successor as president of the Royal Society (1727). He had been created a baronet and physician general to the army (1716), and was appointed royal physician (1727). His museum and library of 50,000 volumes and 3560 MSS., offered at his death to the nation for $100,000, formed the commencement of the British Museum. He contributed numerous memoirs to the *Philosophical Transactions*, and published in 1745 a treatise on *medicine for the eyes.* But his great work was the *Natural History of Jamaica* (1707-25).

Slope-angle. In *optics,* the angle included between a ray and the axis when the former passes through an object-point or image-point located upon the axis. See also **Object-space** and **Image-space.**—(C. F. P.)

Sloped molar. A name given by Harold Gifford to one of the congenital malformations of the teeth observed in inherited syphilis.

Slope of ray. Same as slope-angle (q. v.).

Smallpox, Eye affections due to. Variola. According to Parsons (*Pathology of the Eye,* p. 1324) smallpox was a frequent cause of blindness (1.3—2.5 per cent.) before the introduction of vaccination. Hirschberg calculates it to have been as high as eight per cent. Intra-uterine infection from the mother may cause phthisis bulbi (Panas). From 38 to 78 per cent. of eye diseases from variola affect the cornea (H. Cohn). They generally show themselves from the twelfth to the fourteenth day; never before the tenth day (Makuna). The eruption on the lids causes edema and secondary cellulitis of the face, which may be followed by distortion of the lids (Landesberg). There is generally infective conjunctivitis, sometimes with marked chemosis (Zülzer) or hemorrhage (Gorkom). Pustules may form on the conjunctiva; Adler says in 30 per cent., Hebra in 1 per cent. of the cases. Wagenmann reports a case in which the eruption was confined to the conjunctiva. There has been much discussion as to whether the keratitis is due to pustules (Horner); and it is now generally agreed that it is not. Small, circumscribed infiltrations, interstitial keratitis and hypopyon ulcer have been rather frequently observed. Hirschberg has noted neuroparalytic keratitis; Manz and Adler keratomalacia. The severity of the corneal complications is not always proportional to the general disease.

Primary iritis occurs in from 13 to 17 per cent., it is generally part of a uveitis with choroiditis and vitreous opacities, and may lead to complicated cataract. Simple plastic iritis and chronic iridocyclitis also occur. Retinal hemorrhages, retinitis, albuminuric retinitis, ure-

mic amaurosis and detached retina have been reported. Optic atrophy, neuroretinitis choked disc, retrobulbar neuritis, glaucoma (hemorrhagic glaucoma in hemorrhagic smallpox) dacryocystitis, lachrymal fistula, dacryoadenitis, periostitis and many other sequelæ are on record. Groenouw in the Graefe-Saemisch *Handbuch,* XI, 1, 1903, gives a full bibliography to date.

Smallpox manifests itself on the *eyelids* in the papular, vesicular, and pustular stages. The integument becomes swollen and edematous as well as bright-red in color. A more or less marked conjunctivitis shows itself, and it is sufficiently severe to cause the escape of an appreciable quantity of muco-purulent secretion. The eyelids themselves burn and itch. Efforts to relieve this by rubbing with the fingers will produce inoculation of non-affected parts of the skin and of the conjunctiva. An efficient means of treating the itching is by the use of red rays, which not only alleviate this symptom, but prevent subsequent pitting. In any event, the further development of pus must be arrested. This is to be done by applications and instillations of efficient antiseptics. The eruption, although not commonly severe on the lids, being usually discrete in its distribution, at times is aggregate and even confluent.

Corneal inflammations and ulcers may develop as an extension from the pustules situated at the limbus, but more frequently they appear independently. The condition may also result from endogenous infection.

The ocular complications of small-pox are reviewed by Del Monte (*Ann. di Ott.,* XI, p. 852, 1912. *Arch. di Ott.,* XVIII, p. 663, 1912) on the basis of the statistics of Italy. Although the conjunctiva and iris may be affected, only the corneal lesions are of much importance. Exceptionally a pseudomembranous conjunctivitis occurs, which is always followed by death. The corneal complications include small superficial lesions, ulcers with necrotic base, those produced by pyogenic bacteria, and corneal pustules. The corneal complications are more frequent in children. The appearance of a diffuse epithelial clouding, or of deep purulent infection of the cornea, between the end of the eruptive period, and the beginning of desiccation is a sure sign of death. The only lesion of the iris is a mild unilateral iritis that occurs in adults.

Smear, Direct. See **Direct smear**, p. 4019, Vol. VI of this *Encyclopedia.*

Smee, Alfred. A celebrated English electrologist, surgeon, and ophthalmologist. Born June 18, 1818, at Camberwell, near London, he studied at King's College and St. Bartholomew's Hospital, both in London, and soon was surgeon at the Royal General Dispensary.

Shortly afterward, he was surgeon to the Bank of England and at the Central London Ophthalmic Hospital. In 1840 he became a member of the R. C. of S., in 1841 a Fellow of the Royal Society, and twelve years later a Fellow of the Royal College of Surgeons. He it was who invented Smee's battery (an improvement on the voltaic pile) pantoscopic spectacles and the visuometer (q. v.) He died of diabetes Jan. 11, 1878.—(T. H. S.)

Smerlin. The gall of the smerlin, or loach, was highly esteemed by Pliny and Dioscorides as an all-round remedy for diseases of the eyes. It was thought to be especially useful in leucomata and hypochysis (cataract).—(T. H. S.)

Smith—Indian operation. See **Cataract, Intracapsular extraction of,** p. 1522, Vol. III of this *Encyclopedia.*

Smith, J. W. An American who devised, about 1878, the raised-dot alphabet for the blind, known as American or modified Braille. See **Alphabets for the blind.**

Smith, Nathan Ryno. A well-known early Baltimorean surgeon and ophthalmologist, son of the more distinguished Nathan Smith and grandfather of Dr. Samuel Theobald, of Baltimore. Born at Concord, N. H., in 1797, he received both his classical and his medical education at Yale University, in which institution his father was a professor. His medical degree was received in 1823. He taught for a time in medical schools at Philadelphia, and Lexington, Ky., but spent the greater portion of his life as teacher and practitioner at Baltimore. He was widely known as an operator on the eye, and invented a number of useful ophthalmologic instruments. The most important of these is his knife for dividing strictures of the nasal duct. He died at Baltimore in 1887.—(T. H. S.)

Smith's vertical illuminator. An illuminator devised by H. L. Smith for illuminating opaque objects for high powers. It consists of an annular silver reflector placed at an angle of 45° just above the back combination of the objective. The light passes through an opening in the tube of the microscope or special piece holding the reflector, and is reflected down through the objective to the object.

Smith, William F. A well-known ophthalmologist of San Francisco, California. Born at Urbana, Ohio, April 1, 1845, he served in the Army of the North throughout the greater portion of the Civil War. His medical degree was received at the Miami Medical College, Cincinnati, in 1867. He then was sent to Heidelberg, Germany, for a number of years by Larz Anderson, of Cincinnati, in company with Fred Anderson, Anderson's son.

Returning to America, he settled as ophthalmologist at San Fran-

cisco in '69 or '70, and soon gained a wide reputation as an ophthalmic and aural operator.

In 1884 he removed to Chicago, where, also, he was very successful. He succeeded Dr. Sigismund D. Jacobson as ophthalmologist to Cook County Hospital in 1885, a position in which he was himself succeeded by Dr. Boerne Bettman in 1890. In 1890, he was appointed as ophthalmologist to the Alexian Brothers Hospital in succession to Dr. F. C. Hotz. In 1891 he was himself succeeded in this position by Dr. Casey A. Wood.

William F. Smith.

Dr. Smith was twice married, first to Miss Emma Spain, by whom he had a son, Paul R. Smith. His first wife having died, Dr. Smith married, in 1873, Miss Endon Virginia Bascom, daughter of Dr. Louis Hazelton Bascom, of Louisville, Ky. Of the union was born a son, Dr. Larz A. Smith, now a prominent ophthalmologist of San Francisco.

William F. Smith died at Chicago in April, 1901.—(T. H. S.)

Snail. In ancient Greco-Roman times, snails, reduced to ashes and mixed with the white of egg, were rubbed upon the forehead, as a remedy for "rheuma" (any discharge from the eye). The unmixed ashes were also dusted into the eye to remove corneal cicatrices. So employed, it had, perhaps, about the same effect as calomel.—(T. H. S.)

Snake bite. The results of a venomous snake bite are local and general. Pain and swelling are followed by local paralysis, and by infiltration of the surrounding parts. The general symptoms are shock, depression, faintness, hurried respiration, exhaustion, lethargy, incoördination, paralysis, unconsciousness, convulsions or coma, and death. Snake poison paralyzes the nerve centers and sometimes the peripheral nerves, and causes profound alterations in the blood, which in man usually remains permanently fluid after death from snake bite. The poison is also septic, and when death does not follow, sloughing and hemorrhage occur. Injected into a large blood-vessel, snake virus causes almost immediate death. Attempts should be made to prevent the spread of the virus from the bite. This may be done by a tight ligature between the wound and the heart, and by immediate excision of the bitten part, or by its thorough destruction with a cautery. The part may also be sucked, though this procedure is not altogether free from danger to the operator. The wound should also be enlarged by incision, and into it should be rubbed crystals of potassium permanganate. Stimulants, such as alcohol, ammonia and strychnine, should be given to avert exhaustion; and should respiratory paralysis threaten, artificial respiration may be necessary.

In the case of the more deadly snakes "there is only one fairly reliable treatment, that by serum therapeutics—the injection of considerable quantities of serum of animals which have been partially immunized by repeated doses of snake-venom" (Martin). This serum is known as antivenene. A horse, into the veins of which a non-fatal dose of snake poison had been injected, is proof against the ordinary minimum lethal dose of snake poison; and if gradually increasing doses of the poison be administered, the serum becomes so highly antagonistic to the virus that snake poison sufficient to kill fifty non-immunized horses may be injected without fatal result. Further, the blood serum of the protected horse is itself protective, and confers some degree of immunity when injected into another animal. Unfortunately one serum does not confer immunity against all varieties of snake. A serum thus obtained is produced in the government laboratory at Bombay, and is used successfully in India for persons bitten by the cobra.—(*Standard Encyclopedia.*) See, also, **Serpents,** and *Snake-bite* under **Toxic amblyopia.**

Snake poison. SNAKE VENOM. See **Serpents**; also **Snake bite.**

Snakes. See **Serpents.**

Snakes, Eyes of. See **Comparative ophthalmology**, p. 2519, Vol. IV of this *Encyclopedia.*

A. Rochon-Duvigneaud (*Prac. Med. Series, Eye,* 1918) refers to the well-known fact that snakes shed an external layer of the cornea with an annual renewal of the body integument, and that the transparent filament so discarded resembles closely a watch glass set in the surrounding skin.

It may be said that the transparency and other normal qualities of the vertebrate cornea are variously protected; 1, by movable eyelids (including the third eyelid, or nictitating membrane of birds, and some reptiles); 2, by eyelashes and eyebrows. An examination of the outer covering of the cornea of numbers of snakes made by the author shows it to be insensible and that it exhibits all the characters found in the scales of the reptile or in the finger nails of the higher mammals.

The ophidian cornea is not kept clean either by lachrymal secretion or by the winking action of the eyelids, so that some other means must be adopted to preserve its transparency. This need is all the more urgent because the cornea of the snake is more exposed to injury than in the majority of animals by reason of the habit of crawling and darting along the ground. The head is thus constantly liable to come in contact with thorns, twigs, stones, etc., and the cornea to be scratched and otherwise injured by these objects.

Worm-like fishes that make their way along the beds of the sea, lakes, rivers and other bodies of water—the common river eel, conger eel, the lamprey, etc.—are also more liable to this form of injury than fish whose habitat is clear water. They consequently have "eyes under their skin" although their corneæ are not regularly renewed as in the ophidia.

Microscopic examination of the snake's cornea in a large number of instances demonstrates the presence of a transparent horny covering over the true cornea that permits a certain movement of the latter beneath it. This is the scale-like covering shed every summer by the snake. It appears to be laid upon but does not form an integral part of the corneal tissues; it is not, indeed, a true layer of the cornea but is continuous with the epithelial covering of the rudimentary lids of the animal. The writer speaks of it as a complete, fixed, transparent protective cuirass beneath which is the free-lying, detached, mobile eyeball.

Sneezing consists in a sudden violent expiration, preceded by one or more inspirations. During the expiration the fauces are generally

closed so as to direct the current of air through the nose. Sneezing is most frequently produced by the presence of irritating substances in the nose, and indeed its purpose seems to be mainly to expel these from the nasal cavities. Sneezing is therefore a "reflex act," and as such is beyond the control of the will. It may, however, sometimes be prevented by the application of a strong stimulus to the nasal nerve, such as by compressing at its exit from the nose.

The act of sneezing has been *responsible* (as the determining cause) *for ocular hemorrhages, for detached retina,* for the rupture of partially healed wounds, such as incisions, etc.

Snell, Simeon. A famous English ophthalmologist, an authority especially on miner's nystagmus, the prevention of industrial eye injuries, and the extraction of foreign bodies from the ocular interior by means of the electro-magnet. Born the son of a West Country surgeon, near Launceston, England, in October, 1851, his early education was received at Mannamead School, Plymouth, his medical training at Leeds, Guy's Hospital, and the Royal London Ophthalmic Hospital. In 1872 he became M. R. C. S., and, the following year L. R. C. P. Settling in Sheffield as ophthalmologist, he there remained until his death. For a time he lectured on anatomy at the Sheffield Medical School. In 1874, however, he was appointed ophthalmic surgeon to the Sheffield Royal Infirmary, a position which he never resigned. Snell was one of the founders of Sheffield University, and its first professor of ophthalmology. In 1892 he was made a Fellow of the Royal College of Surgeons of Edinburgh. In 1908 he was awarded the Middlemore Prize, consisting of a check for £50 and an illuminated scroll, by the Council of the British Medical Association, for the general excellence of his work in ophthalmology. At the time of his death he was president of the British Medical Association. He was also ophthalmic surgeon to the Sheffield School for the Blind, and consulting ophthalmic surgeon to the Mexborough Hospital. He passed away in the prime of life, Apr. 17, 1909, aged only 57 years. He was a very friendly man, of a happy and cheerful disposition, and an indefatigable worker. His funeral occurred at Fulwood, England, and was attended by a large crowd from almost every portion of the British isles. Snell left a wife, two sons and three daughters.

His most important ophthalmologic writings are as follows: 1. On a Peculiar Appearance of the Conjunctiva in Some Cases of Night Blindness. (*Lancet*, 1876; *Trans. of the Oph. Soc. U. K.*, 1881.) 2. A Case of Acute Glaucoma, caused by Atropine and Cured by Eserine. (*Trans. of the Ophth. Soc. U. K.*, 1882.) 3. Extraction of Cataract by a Shallow Lower Flap, with a Record and Analysis of 121 Opera-

tions. (*Brit. Med. Jour.*, 1883.) 4. The Electro-Magnet and Its Employment in Ophthalmic Surgery, with Special Reference to the Detection and Removal of Fragments of Steel or Iron from the Interior of the Eye. (1883.)—(T. H. S.)

Snellen, Hermann. A famous Dutch ophthalmologist, inventor of the well-known "Test-Types for the Determination of the Acuteness of Vision" and of a number of other devices in almost universal employment. Born in 1834 at Zeist (Utrecht) the son of a well-known physician, he received his medical degree at Utrecht in 1857, his dissertation being "Experimentelle Untersuchungen über den Einfluss der Nerven auf die Entzündung." Devoting himself to ophthalmology (he had already been a pupil of Donders) he settled in Utrecht, and in 1862 was first physician and docent for ophthalmology in the Netherlands Hospital for Eye Patients at Utrecht. In 1877 he became Professor Ordinarius. Snellen invented, in addition to the well-known test-types, the celebrated test for simulated one-sided blindness by means of green and red letters viewed through red and green glasses; operations for trichiasis, entropion, and ectropion; the "Snellen reformed" artificial eye; the aluminum shield as a substitute for bandages in the after-treatment of cataract, and various improvements in the desks and seats of schools. In 1894 he founded the Nederlandsch Gasthuis voor Ooglijders at Utrecht. Numerous honors flowed to him, of course, among them the honorary fellowship of the Royal College of Surgeons at Ireland in 1892. He died Jan. 18, 1908, aged 73. His son, Hermann Snellen, Jr., is the present well-known professor of ophthalmology at Utrecht.

Snellen was a man of charming personality, an all-around scholar and gentleman. He spoke to his patients freely in Dutch, German, French and English, and was equally kind and considerate in all these languages. He was a man of strong predilection for English people and English institutions, and nearly all his children were given English names. The hospitality of his home is a matter of kindly recollection to hundreds of foreign students and physicians. For the following anecdote the writer is indebted to the "*Ophthalmic Review*" for Feb., 1908: "A personage of importance came to him in trouble, needing an operation for glaucoma, but unable to undergo it because he could not take chloroform and could not stand the operation without. Both courses had been attempted and abandoned as impossible. Snellen, doubting the reality of the difficulty, undertook the case. Trying first without chloroform, he found the patient so devoid of self-control that he could not proceed; trying then with chloroform he had to desist by reason of alarming symptoms. The patient was

Herman Snellen, Sr.

in despair; not so Snellen. 'We will try again, tomorrow,' he said. 'Give me leave to treat you as may seem best at the moment and we shall still succeed.' The patient willingly consented. Again, at the critical moment, he became unruly, but this time instantly received a sharp reprimand and a sounding slap on the face, which so far startled or terrified him into stillness that Snellen was able to make the iridectomy without mishap—and to earn thereby the gratitude of the patient.''

Snellen's most important ophthalmologic writings are as follows: 1. Uber de Methode der Oogheelkundige Klinik. (Inaugural address; 1877.) 2. De Aandoeningen van Cornea en Conjunctiva. (*Verslagen Gasth. voor Ooglijders*, 1860.) 3. Iridesis, Entropion-Naad. (*Ibid.*, 1862.) 4. *Optotypi ad Visum Determinandum.* (Utrecht, 1862; Dutch, English, French, German, Italian Transs.; several polyglot editions.) 5. Die Richtung der Hauptmeridiane des Astigmatischen Auges. (*v.* Graefe's *Archiv f. Ophthalm.*, 1874.) 6. Die Stokes'sche Linse mit Constanter Axe. (*Ibid.*, 1874.) 7. Ueber die Durchschneidung der Ciliarnerven bei Anhaltender Neuralgie eines Amaurotischen Auges. (*Ibid.*, 1874.) 8. Ophthalmometrie. Die Functionsprüfungen des Auges. (In collaboration with E. Landolt. Graefe-Saemisch, *Handbuch der Gesammten Augenheilkunde*, 3. Thl., 1874.) 9. Das Phakometer zur Bestimmung von Focus and Centrum der Brillengläser. (Zehender's *Klin. Monatsbl.*, 1876.) 10. Gleichseitige Monoculäre Prüfung bei den Augen mittelst Farbiger Sehproben. (*Ibid.*, 1877.) 11. Sympathische Ophthalmie. (*Nederl. Tijdschr. v. Geneesk.*, 1881.) 12. Progressive Schoolbanken. (*Versl. van de Vereen. tot Verbetering der Volksgezondheid*, 1883.)—(T. H. S.)

Snellen reform eye. See p. 623, Vol. I, and p. 10398, Vol. XIII of this *Encyclopedia*.

Snellen's operation for ptosis. See p. 10495, Vol. XIV of this *Encyclopedia*.

Snellen's sign. A loud hum or bruit synchronous with cardiac systole, in exophthalmic goiter. David Riesman (*Journ. Am. Med. Assocn.*, p. 1381, 1916), records a case in which this heart sound was distinctly noticed. He draws attention to the fact that it was first reported by Snellen (Donders in Graefe's *Archiv f. Ophthalm.*, p. 102, 1871). He also notes that Duroziez (*Gaz. des Hôp.*, June 16, No. 69, p. 548, 1874) heard a sound over the eyes in exophthalmic goiter, but as he declared that the same bruit was audible over the normal eye, we must accept his own explanation of it: that it was due to the rotary movement of the eyelids, hence not the sound in question. Schönfeld, in the course of a description of a single case of exophthalmic goiter, says,

"On placing the stethoscope over the eye, a hum synchronous with the pulse could be heard." Carrington and Drummond also give clear descriptions of the bruit.

The bruit, like other signs of exophthalmic goiter, is not constant, and the writer has noticed a similar sound in aortic insufficiency, which is not surprising since many of the vascular phenomena of the two affections are very similar.

Snellen test-chart. See p. 2016, Vol. III and elsewhere in this *Encyclopedia.*

Wolfberg (*Archiv f. Ophthal.*, p. 249, 1916) reminds us that if the important characteristics for recognizing the letters are called indices, *e. g.*, the gap in C, without the perception of which C would be seen as O, all indices ought, according to Snellen's principle, to appear under the same visual angle of 1′. Analyzing, however, the single letters, one finds aside of indices of 1′ (as in C R S), others of 2, 3 and 5′. There are also letters (A V L T) which are recognized by their lines whose width corresponds to 7′, whose length to 5′. The indices are never smaller than 1′ and never larger than 5′, no matter whether they represent lines or intervals. Those letters of the same optometric line are read easiest which are recognized by lines of 5′, the hardest those in which the index is only 1′. The writer unites these extreme indices of Snellen's optotypes, *viz.* a line of 5′, interval and point of 1′ on an octagonal card, on the back of which is only a line of 5′. The card can be held in all different directions, so that it can not be learned by heart. The person who recognizes the point at 6 m. must also read the more difficult letters of Snellen's row 6/6, and the person who recognizes only the line, not the point at 6 m., can read only the easier types of this row. Wolfberg consequently always commences his tests with his card.

Snellius, Wilebrord, of Leyden (1591-1626). This man wrote a work on optics, which remained unpublished at the time of his death. Some writers aver that Descartes availed himself, secretly, of this unpublished work.—(T. H. S.)

Snell's law. The sine of the angle of incidence bears a constant relation to the sine of the angle of refraction for two given media.

Snell's magnet. See **Electromagnet**, p. 4253, Vol. VI of this *Encyclopedia.*

Snow-blindness. Snow ophthalmia. Ophthalmia nivalis. See p. 1196, Vol. II, and p. 3106, Vol. IV, of this *Encyclopedia.* In addition to the observations made there, Geo. H. Mathewson (*Ophthalmic Record*, July, 1913) believes that the cornea is involved in all severe cases, and that a blister or bleb forms, corresponding to the blisters seen in

sunburn of the skin. The blister bursts very early and leaves a shallow painful ulcer. Two of Mathewson's reported cases showed a shallow corneal ulcer.

Gonin (*Annales d'Oculistique,* Sept., 1908) believes the so-called snow ophthalmia *(ophthalmia nivalis)* to be less frequent than is usually supposed.

On inquiry of the Swiss Alpine Club, he finds that conjunctival irritation with photophobia and blepharospasm is frequent, but generally of so mild a character that patients generally recover in a few days without consulting a specialist.

Guides and tourists have learned to provide themselves with protecting glasses and their eyes are not usually affected unless the difficulties of the route compel them to lay aside the glasses or a misty atmosphere makes them believe that they are not necessary.

When the eyes have been exposed to reflection from the sun for some hours the symptoms of ophthalmia are those that Reich has described as affecting workmen occupied in clearing the roads; viz., the eyelids and conjunctiva are red and a little swollen, the pupils are strongly contracted, there is slight congestion of the retina, and intense and painful photophobia.

The supposed blindness that has been described is due chiefly to spasm of the lids and when these are once opened, vision is found to be little or not at all diminished. The visual field was affected in only two of the subjects examined. Ulceration of the cornea has been observed, but it is rare.

The symptoms do not occur suddenly, like the retinal dazzling from looking at the sun or at a brilliant electric light, but some hours later —most frequently in the night or on awakening in the morning. The symptoms usually yield promptly to iced compresses or hot stupes, protection from the light and applications of sulphate of zinc. Some patients get relief from applications of white of egg to the conjunctiva. Exceptionally, there is a persistent dimness of vision, which the author is disposed to attribute to continued myosis and which yields to darkness and cocain or atropia.

He has noted in fifty cases only two in which visual troubles resulted from probable retinal causes, and thinks that the expression "snow-blindness" is incorrect. It is better to speak of snow ophthalmia as we do of electric ophthalmia. These affections are analogous not only in their symptoms, but in their cause, which, in all probability, is the action of violet and ultra-violet rays.

Widmark demonstrated that the luminous rays of the spectrum have no decided action on the conjunctiva or cornea, and the caloric rays

but little; while isolated ultra-violet rays produce chemosis of the bulbar conjunctiva, epithelial desquamation of the cornea, myosis, and sometimes discoloration of the iris. He also showed that it is not the direct influence of the sun that produces snow ophthalmia, but rather light reflected by the snow, which is richer in ultra-violet rays than is direct sun-light.

This fact is confirmed by experience, since a large proportion of reported cases of snow ophthalmia have occurred in cloudy weather or even at the time of a dense fog.

There is a decided individual difference in susceptibility to snow ophthalmia. While slightly-tinted glasses suffice to protect some people, dark-smoked glasses prove insufficient protection for others. Dark-smoked glasses are inconvenient and the author prefers those of yellow tint which absorb the ultra-violet rays. He has personally found them a sufficient protection. Even ordinary plain glass intercepts a considerable proportion of the ultra-violet rays, and many people escape snow ophthalmia by wearing the correction of their ametropia. These rays are also intercepted to a considerable extent by the lens.

The irritation of the external integuments of the eye is not due, as was formerly thought, to reflex action from retinal excitation, but results from direct action of the injurious rays upon the eyelids, the conjunctiva, the cornea and the iris. Protecting glasses should have wire gauze or glass sides to obstruct the oblique rays of light.

Erythropsia, in the production of which the ultra-violet rays act an important part, sometimes results from snow reflection, and may occur without accompanying irritation of the conjunctiva or cornea.

Galli-Valerio (*Annales d'Oculistique*, March, 1911) says of Switzerland that in summer, there is no risk of "snow-blindness," for those tourists who, not indulging in mountaineering, are content to keep to the lower levels. In winter, however, the possibility of an attack is much greater, for throughout the whole day the eyes are exposed to the glare from the surface of universal ice and snow.

The above-mentioned article should be read in the original, for it consists for the most part of a very graphic record of the author's personal experiences. We may content ourselves by noting the conclusions which are drawn as to treatment. The treatment of Swiss snow ophthalmia, as prescribed by M. Dufour, consisted of: (1) Astringent lotions. (2) Subcutaneous injections of strychnin in the region of the temple. (3) Instillations of a solution of pilocarpin. (4) Avoidance of any strong light and, at first, confinement in a darkened room. The writer had an attack brought on by exposure to a

brilliant sun whilst on a glacier and mountain expedition. It is interesting to note, however, that a brilliant sun is not an essential factor. The author comments very strongly on the inutility of the various forms of tinted glasses to be found in the alpine stores and believes the color too feeble to be of any protective value, and that the all important question of fitting is not considered at all. Ample space for the entrance of harmful reflections is left at the sides and lower margins of the glasses.

S. Holth (*Ophthalmoscope*, p. 71, Feb., 1915) has had considerable experience with arctic explorers and believes, in gaining protection from the dangers of snow-blindness, that open spectacles are best and that all more or less hermetical arrangements of goggles for the exclusion of side lights are superfluous, and serve only to moisten the glasses. The best frame is the common open spectacle frame, which should be fitted with large mussel-shaped "Euphos" glasses.

Cases of *red-green blindness after glaring by snow* are reported by W. Lohmann (*Archiv f. Augenheilk.*, 79, p. 35, 1916). In the first case the color disturbance was transient. In the second case a congenital alteration of the color-sense showed a further transient deviation by the glaring through snow, which under constant observation decreased to a stationary condition, as it is found in congenital extreme green anomaly.

Judson Daland (*Ophthalmic Record*, March, 1917), after visiting among 3,000 Eskimos comes to the following conclusions: (1) The Eskimo possesses no immunity from snow-blindness. (2) Snow-blindness occurs on cloudy days or dark days as well as on sunny days. (3) One attack of snow-blindness predisposes to another. (4) Snow-blindness occurs in animals. (5) Excellence of snow-goggles invented by a primitive people in preventing snow-blindness. (6) The association of conjunctivitis and corneal erosions with chorioretinitis in snow-blindness. (7) The ultra-violet ray causes conjunctivitis, corneal erosions, and possibly chorioretinitis.

See, also, **Snow-burn.**

Snow-blink. The appearance due to reflection of light from a surface of snow.

Snow-burn. Although this condition when it affects the eye produces what we know as *snow-blindness*, yet, as a writer in the *Journal of the Am. Med. Assocn.* points out, all parts of the body—naked or otherwise—may suffer from it. He says that snowburn, especially in the mountains and on glaciers, is much more severe than waterburn, and waterburn is severer than ordinary sunburn. There are two factors contributing to this: Light at high altitudes is much richer in actinic

rays than light at lower levels, because as light travels down through the atmosphere it loses its actinic rays by absorption much more rapidly than its heat rays. We, therefore, who live at the bottom of the aerial ocean, are used to a light much poorer in actinic rays than that which we get when we ascend into the mountains.

There is still another reason for the severity of snowburn. A fine, white powder, such as snow, readily absorbs the long waves at the red end of the spectrum and refracts the short ones at and beyond the violet end, so that not alone is the light itself at high altitudes richer in actinic rays than that to which we are ordinarily accustomed, but a greater proportional number of those rays are refracted, and they therefore contribute to causing the burn. A patient who was severely snowburned in Nevada said he noticed that on that day the snow and ice had looked particularly blue. The blue color often noticed in snow and ice is ascribed, in part at least, to the refraction of the rays at the violet-end of the spectrum.

Still another reason for the severity of snowburn and waterburn is the greater quantity of light. The individual is exposed not alone to the direct light of the sun, but also to the light coming from the reflecting surface. Besides this, the reflected light strikes the exposed surfaces at an unusual angle, and so takes the cells by surprise. Cells which, throughout the foregoing years and even generations passed through by the individual, have been comparatively sheltered are suddenly exposed to direct injury by the reflected light rays. In addition to this, the beam of light passes through the cooled air over the water or snow and thereby loses a great quantity of its long, red, heat waves, and the man exposed, not feeling the pain or discomfort of the heat, is not warned of the damage the short painless actinic waves are causing until the injury is very great.

Snow, Carbon dioxide. This agent is described in Volume I, p. 447, and on p. 1404, Vol. II, of this *Encyclopedia*.

Snow-eyes. A crude form of snow spectacles long in use among the Eskimos. See **Blindness, Snow.**

Snow-gauge. An instrument resembling a rain-gauge, for receiving and measuring falling snow.

Snow-goggles. SNOW-SPECTACLES. Screens used to shade the eyes in some degree from the glare of light reflected from a surface of snow.

Snow ophthalmia. See **Snow-blindness.**

Snydacker's color squares. See p. 2474, Vol. IV of this *Encyclopedia.*

Soamin. A proprietary drug—sodium para-animophenylarsenate—used like atoxyl in syphilitic diseases.

R. H. Elliott (*Ophthalmoscope*, Jan., 1913) reports a case of optic

atrophy following intramuscular injection of soamin. The patient, a man of 32 years, with secondary manifestations of syphilis, was given ten doses of ten grains each on alternate days. Seven days later, the vision of the right eye became blurred and he was greatly annoyed with photopsia. Examination showed right vision with correction 6/9, left vision 6/6. Right disc was very pale, except for a narrow margin on the inner side. The left disc was also very slightly paler than normal. The right visual field showed extreme contraction, and the left field was also somewhat contracted. See, also, **Orsudan.** Probably the toxic action of these and other *aryolarsenates* is due to the anilin and to the arsenic in them.

Soap. Hard soap. Sapo. Sapo durus. Castile soap. Although the name "soap" is generally applied to the product made from olive or some other fixed vegetable oil and sodium hydroxide, yet it is generally used for all compounds of fatty acids with alkaline bases. With earth bases or metals the product is insoluble, such as lead plaster and lime liniment.

Soft soap (sapo mollis, sapo viridis, green soap) is made from potassium hydroxide and olive, almond, linseed or similar oil.

Curd soap, tallow or animal soap, made from tallow or suet, is sold in very light-grayish masses or cakes.

Liniments, tinctures and other preparations, official and other, are employed for cleansing the skin.

Although this detergent remedy is never applied to the eyeball or conjunctiva, it is a most useful adjunct to sterilization of the lid skin and the dermal field of operation. As a preliminary to the application of ointments in blepharitis various forms of soap are used for cleansing purposes, one of the best of these being pure castile soap. A lather made with it may be rubbed with impunity on the margins of the lids with sterile cotton in diseases of that locality as well as in the attempt to sterilize the cilia and palpebral edges previous to operation.

S. Lewis Ziegler advises a neutral liquid soap, especially adapted for use in ophthalmic surgery. It contains but 10 per cent of alcohol, 10 per cent of glycerin, and is made from cotton-seed oil, which is a light, bland oil. The soap is a very thorough cleanser, has the advantage of not producing a lather, and, because of its lack of alkalinity it is not irritating to the skin and can be used without danger in the conjunctival sac.

Soap-wort. The same as "fuller's herb" and "fuller's weed." *Saponaria officinalis L.* According to Pliny and Dioscorides soap-wort was an excellent agent for the clarification of the sight. It formed an ingredient of numerous ophthalmic ointments.—(T. H. S.)

Sociology, Ophthalmic. The social relations and phenomena of ophthalmology are quite as important and numerous as those of other branches of medicine, and they have been extensively studied under many headings in this *Encyclopedia.* Prominent among them are the efforts to prevent blindness and teaching the public and the profession how to care for and conserve eyesight. An important factor in the bearing of ametropia to sociology, as Zentmayer has pointed out, is the relation of the latter to conservation of vision, to efficiency of labor, as a factor in education and in the moral development of the child, to its influence upon the mental processes of the individual, and in its relation to workingmen's compensation laws, and as a factor in safeguarding entrusted human lives. See **Visual economics.**

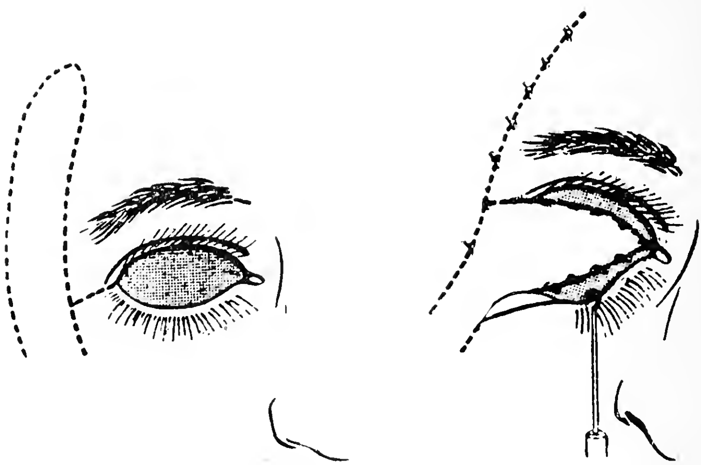
Socket, Contracted. CICATRICIAL SOCKET. CICATRICIAL ORBIT. This subject has been considered on p. 1107, Vol. II and on p. 9160, Vol. XII of this *Encyclopedia*, as well as under **Enucleation** and its substitutes. To this information may be added an account of the procedure advised by Verhoeff (*Oph. Year-Book*, p. 312, 1916). The orbital cavity is enlarged by dissecting away all the scar tissue. If this is not sufficient the normal conjunctiva is undermined so that it will spread away from the denuded area or areas. A Thiersch graft is spread out on a double sheet of Cargile membrane [prepared ox peritoneum] and closely applied to a glass ball of the same size as that in the orbit. The glass ball bearing the Cargile membrane and graft is inserted into the orbital cavity. At the end of five days the glass ball is removed, cleaned and replaced in the orbital cavity. This should be repeated every two or three days. At the end of two or three weeks the glass ball may be removed and replaced by an artificial eye.

Weidler has performed the following operation for restoration of contracted socket. After external canthotomy and removal of the cicatricial tissue, freeing the lids, a large tongue-like flap, which was one-half inch wide and an inch long, including the pedicle, was taken from the lid and placed in the orbit and secured by several stitches.

In order to restore the orbital cavity Carlotti and Bailleul transplanted a fragment of costal cartilage into the orbit and covered this cartilage with a pedunculated skin graft.

Burton Chance has reported (*Annals of Ophthalm.*, p. 427, April, 1915) a case of *contracted socket enlarged by the method of Maxwell, of Dublin.* The patient, a woman of fifty-eight years, had had her left eye removed many years after a severe injury. She had been under observation interruptedly for fifteen years. Within the past year she reported, after a lapse of several years, because the

socket had contracted so much that no sort of eyeball could be held in place. Two dense, pillar-like bands connected the upper and lower mucous surfaces. These were bisected in the manner devised by Berens, and this procedure deepened the space somewhat. Six months later an island of tissues from the lower lid was implanted into the socket through an incised space connecting the orbital sulcus with the skin of the lower lid. The socket was thus enlarged to a degree equal to the area of the transplanted skin. A paraffin covered lead plate was inserted and worn continuously. The four sutures from the socket, and the five from the external surface of the lid, were removed on the seventh day. The union of the lid was all that could



Danis Operation for Contracted Socket.

Outline of flap, and incision connecting with socket.

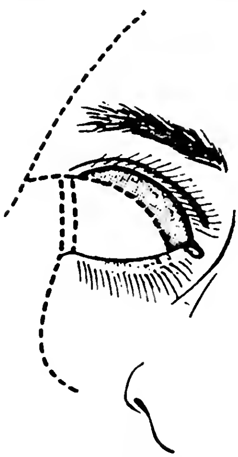
Flap transplanted into socket and stitched in place. Skin stitched together where flap was obtained.

be wished for. The lid was no longer drawn into the orbit, and a modified glass eye was worn for two weeks, when it had to be removed because a sinus had formed at the anterior line of union of the skin and mucous membrane, through which the discharges burrowed and pointed on the outer surface of the lid. This was healed, and a somewhat larger shell could then be worn. Further operations were intended to widen the space under the upper lid.

An operation for the restoration of a contracted socket so that it will hold an artificial eye has been described by Danis (*Oph. Year-Book,* p. 313, 1916). He begins by making a horizontal incision 1 cm. outward from the external canthus. At the end of this incision he forms a flap from the skin of the temple, as shown in figure. This

flap nourished by its pedicle is implanted within the orbit, and the skin drawn together to replace it. When it has healed a second operation is done as illustrated. The base of the flap previously transplanted is cut across and a rectangle of skin, 3 or 4 mm. wide, is excised (see figure). The outer extremity of the lower lid is then drawn up to its proper position, and sutures placed in such a way as to hold it there and prevent traction. Danis reports two cases of contraction of the socket treated in this way with easy retention of the prothesis as the result.

The *implantation of a small glass sphere in the shrunken sockets of old enucleations* is advised by Ralston (*Texas State Med. Jour.*, p. 394,



Danis Operation.

After flap has united in socket, showing rectangle of skin removed to allow lower lid to be drawn up in position.

Vol. 12, 1918). He performs vertical incision of the conjunctiva at two-thirds the distance from the outer canthus to the center, avoiding the latter, which is generally drawn back to the optic nerve and depressed. The sides of the incision are undermined in all directions from the external canthus to a point well beyond the center. Then the deeper structures are also incised vertically as near to the outer canthus as possible, the conjunctiva being drawn well back with a strabismus hook. With a sharp knife a slowly executed cut, with excursions above and somewhat below, is made to encircle two-thirds of the orbit. In this way a fairly large sac is made into which the sphere is placed. This cavity must be made a little above the center of the nasal side. Sutures are inserted in such a manner that the two incisions do not fall one over the other, the deeper one being well

covered by smooth conjunctiva. To secure success the sphere must be small.

A practical paper on this subject is that of Schwenk and Posey (*Am. Journ. of Ophthalm.*, Dec., 1918) who state that there are two groups of cases to be considered. In Group A, there is complete occlusion of the socket, and restoration is made by the employment of pedicled flaps taken from adjacent parts. In three cases reported union was firm, and there was no trace of a fistulous tract produced by the passing of the skin flap under the bridge formed by the union of the two pillars of the canthus; nor were they bothered by an outgrowth of hairs from the flap. The desquamation of skin from the flaps gradually subsided, and the sockets became dry, and more and more commodious. The conformer should be retained a long time, and interfered with as little as possible.

The first case was one of entire obliteration of the socket, due to a lime burn. The operation was performed, using a long-pedicled flap obtained from the forehead. The patient was permitted to go home with the conformer in position. But, through lack of attention, it was allowed to slip; and the tissues contracted so that the conformer was no longer retained. A second operation had to be done to remedy this, with the result that an artificial eye could be worn with comfort; and the cosmetic result, apart from immobility of the eye, was perfect.

The second case was also one of obliteration of the socket, due to a lime burn. A similar operation was performed, the canthus being restored by the method employed in the former case after a conformer had been inserted into the amply spacious socket. On the fifth day, however, the stitches holding the pillars of the canthus in apposition gave way, necessitating some time later a refreshening of the edges of the flap, and a lengthening of the pillars. Union was then permanent, and a suitable sized eye was worn with comfort.

In the third case, the eye was lost by a lacerated wound, demanding enucleation. In consequence of faulty technic in this operation, the upper lid was firmly bound down to the sublying tissues by dense cicatricial bands. The lower cul de sac was also somewhat contracted. The operation was performed by the authors' method. Recovery was uneventful. A proper sized eye was then retained without difficulty.

In the opinion of the authors, the Maxwell operation is admirably adapted for the restoration of the lower cul de sac. The objection to it is the tendency that the lid evinces to ectropionize at its outer half, after healing has occurred. This may be partially overcome by making the flap narrower. Another ingenious method has been proposed

by Golovine for securing an artificial eye after exenteration of the orbit.

Group B includes incomplete occlusion of the socket, some of the conjunctiva being still present. Wiener's method is especially applicable to this class of cases. Without having any knowledge of Wiener's contribution, one of the authors (Schwenk), in 1915, while attempting to restore a shrunken socket in which some mucous membrane was still present, used a procedure differing from Wiener's operation only in the location of the cul de sac anterior to the cartilage of the lid, instead of posterior to it. In the Wiener method, a large denuded area, from which the conjunctiva has been taken, is left exposed in the socket, and must be covered with grafts; but in the authors' method, no raw surface at all remains. Dissection is done beneath skin and conjunctiva. This method was used in the following case: A young man of twenty-eight, whose eye had been enucleated eleven years before on account of severe injury, had worn badly fitting glass eyes until cicatricial contraction had prevented their retention. The authors' operation was done; recovery was uneventful, and the result was all that could be expected, a proper sized artificial eye being worn with comfort.

The authors' method consists in undermining the orbital mucous membrane by a submucous incision, followed by a subcutaneous incision at the lid margin, thereby uniting the subcutaneous and submucous cavities. The dissected conjunctiva is transferred into the apex of the subcutaneous cavity, by the insertion of a series of double armed sutures.

Clarence Loeb (*Am. Journ. of Ophthalm.*, Dec., 1918) has reviewed the important essay of Poulard and Real (*Annales d'Oculist.*, p. 41, Jan., 1918), who comment on the lack of permanent results which tend to follow operations for the restoration of the conjunctival sac. Cutaneous flaps are not successful, because they are placed in a cavity already too shallow, which they make more so. Epithelial grafts are less open to this objection, but they are too delicate and the results are poor.

Pieces of glass or hard rubber placed for a long time in the cavity increase it slightly, but cannot distend it because they are loose and can exert no pressure. In order to accomplish this, the writers constructed an apparatus which is comfortable and exerts a selective pressure action on the parts requiring it. This consists of a plate conforming to the upper orbital margin, modelled in the way a dentist makes a plate, held in place by elastic bands which pass around the occiput and prevent its displacement. This makes a firm support for

the active part of the apparatus, which is a vertical steel rod with a groove in a tube attached to the plate. It can be raised or lowered at will. To the lower part of the rod is fastened another tube. Screws permit the rods to be fastened at any length. The second rod terminates in a discoid plate, upon which is to be placed the plastic mass which is to be moulded upon the irregularities of the cavity. By means of these rods the plastic dilating mass can be moved in any direction.

The first step in the operation is to take an impression of the cavity, and a model is made in three pieces. Cicatrices present are cut, and this is followed by application of the dilating apparatus. The disc is covered with a soft plastic mass, which is introduced into the cavity and pressed moderately against the walls so as to take on the contour of the cavity, and especially so as to interpose between the cut lips of the cicatrices. By means of its attachment, the plate is anchored firmly to the orbital margin and remains in place day and night, being removed only once or twice a day to clean the cavity. It is well borne by the patient. On the succeeding days plastic matter is added until the desired result is obtained. Then it is replaced by a definite mass of vulcanized rubber. Epidermization must be complete before the artificial eye is inserted. Even afterwards, the apparatus should be worn at night if there is any doubt about the permanence of the result.

As the Editor (*Prac. Med. Series*, Eye, 1918) has pointed out, the subject of *ophthalmic plastics* has risen to very great importance as one of the chief surgical aspects of the war. One of the principal workers in this field is Charles Higgens whose observations and experiences (*The Lancet*, October, 1916) are well worth study. He has employed quite extensively *celluloid* as a material for making up bone defects, filling cavities and leveling depressed scars, and finds it superior to paraffin and similar agents. He also found a solution of celluloid in acetone and a (secret) trade preparation for making corks watertight of great assistance in raising (by subdermal injection) deep, *i. e.*, depressed, cicatrices. A colleague has even employed with signal success a celluloid plate for closing an opening in the skull. Higgens thinks that there is a great future for these celluloid operations. See, also, **War, Ophthalmic medicine and surgery in.**

Soda. An impure sodium carbonate, called "nitron," was an oft-used remedy in the hands of ancient Greco-Roman ophthalmologists. Boiled in sweet wine, it was thought to be of service in ulcers and scars of the cornea. Those who worked in the nitron pits were said by Pliny the elder to acquire an abnormal clarity of vision.—(T. H. S.)

Sodic cinnamate. See **Hetol**, p. 5913, Vol. VIII of this *Encyclopedia*.

Sodii boras, U. S. See **Sodium borate.**

Sodii thiosulphas, U. S. See **Sodium hyposulphite.**

Sodium benzoate. $NaC_7H_5O_2$. This salt occurs as a white, partially crystalline powder, odorless but of a sweet-astringent taste. It is very soluble in water; sparingly in alcohol.

Among the numerous germicides proposed for ophthalmic use during the past twenty years this agent for a short time held a minor place, having been recommended as a collyrium in 1 to 5 per cent. solution; but it does not appear to possess any advantage over most other antiseptics. It resembles in its clinical relations to eye diseases boric and salicylic acids.

Sodium benzosulphinide. SODIUM BENZOYLSULPHONATE. ORTHOSULPHAMINEBENZOATE. SODIUM SALT OF SACCHARIN. Sometimes, though incorrectly, called "sodium saccharate" (q. v.). It appears as colorless crystals, very soluble in water. It is an antiseptic employed in solutions of 1:6 to 1:3 in keratitis, corneal ulcer, iritis, etc.

Sodium benzoylsulphonate. See **Sodium benzosulphinide.**

Sodium biborate. See **Sodium borate.**

Sodium bicarbonate. It seems strange that this salt is so little used in ophthalmic therapy because it makes a good collyrium for detergent purposes, for irrigating the sac during the treatment of infective diseases of the eye, and as a wash for the lid edges in cleansing the cilia, skin and adjoining mucous membrane from dried secretions. For all these purposes a 1 to 3 per cent. solution in distilled water is quite sufficient. Königstein and others recommend it in ointments of potassic iodide, as in this formula: Potass. iodidi, 0.1 gm. (gr. iss); Sodii bicarb., 0.05 gm.; Petrolati, 3.0 gm. (gr. xlvi).

In painful, marginal ulcer of the cornea Darier recommends the following collyrium, of which this salt forms a part. One drop is to be instilled into the eye from four to six times a day: Dionin.; Cocain. hydrochlor. āā, 0.10; Sodii bicarb., 0.20; Aquae dest., 10.00.

Peter A. Callan finds the following mixture of much service in conjunctival irritation, in conjunctival hyperemia and in mild forms of conjunctival infection: borax, sodium bicarbonate, of each, 20 grains; camphor water 2 fluid drachms; distilled water 4 ounces.

Sodium borate. BORAX. SODII BORAS, U. S. NATRIUM BIBORICUM. SODIUM TETRABORATE. SODIUM PYROBORATE. $Na_2B_4O_7+_{10}H_2O$. This well-known and valuable salt, derived from commercial boric acid, is found in large colorless, inodorous prisms that have a mild, sweetish, cooling and alkaline taste. It readily effloresces and becomes opaque.

Borax is often combined in collyria with boric acid and other agents, but it may, in 1 to 5 per cent. solutions, be used alone as a mild and

soothing detergent in almost every form of conjunctival disease. As a general statement it can be said that borax is indicated in about the same dosage and for the same purposes as boracic acid (q. v.), although its antiseptic value is less. It makes a good collyrium and detergent wash in conjunctival catarrh and hyperemia. A favorite formula is: Sodii boratis, 1.0 gm. (gr. xv); Aquæ laurocerasi, 5.0 c. c.; Aquæ rosæ, aquæ dest., āā 100.0 c.c. (f℥iii f℥iii).

Sodium bromide. See p. 1312, Vol. II of this *Encyclopedia.*

Sodium cacodylate. SODIUM DIMETHYLARSENATE. See p. 1352, Vol. 11 of this *Encyclopedia.*

Merck's *Annual Report,* pp. 2 and 27, 1910, says that in *keratitis bullosa* and other eye affections in which arsenium medication is indicated, Galezowski had good results follow the use of sodium cacodylate. In these cases he combines its internal or subcutaneous use with external application in the form of eye drops or collyria. This author uses the following prescription: Sod. cacodyl., 0.12 gramme (2 grains); Cocain. hydrochlor., 0.25 gramme (4 grains); Paraffin liquid., 15.0 grammes (½ oz.). A few drops to be instilled into the eye two or three times a day.

The results obtained by Bonsignorio from the external use of sodium cacodylate in corneal ulcer and ulcerous blepharitis encourage further trials. In superficial and deep ulcers the results are excellent, the sores healing rapidly from their edges and leaving comparatively slight corneal opacity. Either a 3 per cent. aqueous solution of sodium cacodylate is used, 5 drops being instilled every morning for 15 days, or a 2 to 3 per cent. ointment is applied, a little being used every day for 8 days, and then every other day.

Frank Allport and Alex. Rochester (*Ophthalmic Record,* Sept., 1913) report a case of lime burn in which the remedy was employed. When first seen, the cornea was completely opaque, and the patient had symptoms of acute iritis. He was treated with antiseptic eyewashes, atropin drops, and hot fomentations, and powdered dionin for about a month, without any evident effect on the corneal opacity. After this, he was given an intramuscular injection of 7 grains of cacodylate of sodium, and two or three days later, the cornea began to clear. A week later, the injection was repeated in a 3½ grain dose, and this was repeated every two or three days—seven injections in all being administered. In about five weeks, the whole cornea became completely transparent, with vision of 20/20, with correction.

H. N. Cole (*Journ. Am. Med. Assocn.,* p. 200, 1916) points out that sodium cacodylate, at first claimed as specific in syphilitic lesions, is of small value for that purpose. He contends that careful analysis

proves the contention of Nichols and others. Sodium cacodylate is worthless as a spirocheticide; yet many physicians are depending on this drug today in the treatment of syphilis. Moreover, there is a widely advertised proprietary product on the market, *venarsen*, claimed to be of great value in the treatment of this disease, the main constituent of which is sodium cacodylate. And the dosage is not as large as the writer has employed. He further says that (1) At the utmost, sodium cacodylate has perhaps a slight action on the papular and nodular syphilids, but in no case is it to be compared with even mercury and potassium iodid alone. This is probably to be explained entirely from the tonic action of the arsenic on the system. (2) In cases of syphilis with mucous patches it is worse than useless. (3) In one case there was a drop in the spinal fluid cell count from 65 to 25, but the Wassermann and Noguchi tests remained positive, and two other cases with cerebrospinal involvement, showed practically no change. (4) The contention may be raised that Cole did not employ large enough doses, 0.5 gm. every three days. Routine urine examinations in cases 2 and 4, however, out of a total of ten studied, showed red cells and albumin, the one after four and the other after six injections. (5) The routine positive blood Wassermann in all ten cases was in no instance changed to negative. See, also, **Venarsen**.

Sodium chloride. COMMON SALT. NaCl. Although it is generally held that the terms "physiological salt (or saline) solution" and "normal salt solution" are not synonymous terms the *National Dispensatory* remarks that the "saline strength of these solutions is supposed to be the same as that of blood serum and varies, according to different authorities, from six-tenths to nine-tenths per cent. or, as it is roughly calculated, one teaspoonful of sodium chloride to one pint of water."

Sodium chloride in various aqueous solutions forms a valuable douche to the eye, for irrigating the conjunctival sac, for subconjunctival and intraocular injections, for controlling the effect of silver nitrate and for other purposes. As normal salt solution the douche and spray act mechanically in freeing the sac and eyeball of toxins and microbes; in subconjunctival medication it is employed in from 0.60 to 20 per cent. solution, according to the effect desired; the former solution being preferred for detergent purposes.

T. S. Middleton orders the following ingredients to be made up into four tablets, one or two of which are to be dissolved in an ounce of boiled water and used as a collyrium and compress in the home treatment of simple catarrhal conjunctivitis: Acid. boric., ʒss; Sodii, chlor., gr. xii; Aquæ camphor.; Aquæ menth. pip. āā, m. xvi.

This method insures freshness of the solution. Among other numerous uses of sodium chloride in ophthalmic surgery see **Vitreous, Replacement of the.**

Sodium cinnamate. See **Hetol,** p. 5913, Vol. VIII of this *Encyclopedia.*

Sodium cinnamylate. See **Hetol.**

Sodium citrate. $Na_3C_6H_5O_7$. This is a white, crystalline salt, purgative and antacid in 10-15 grain doses. It is an ingredient of the official *pulvis sodii citrotartratis effervescens.* It has been recommended as an agent in subconjunctival injections and used in five per cent. solutions.

Following the experimental work of M. H. Fischer, H. G. Thomas regards glaucoma as essentially an edema of the eyeball, *i. e.,* "a state in which the affinity of the tissue colloids for water is increased above that which we are pleased to call normal. This is brought about, in the main, through chemical changes in the tissues themselves, whereby substances, particularly acids, capable of increasing the affinity of the tissue colloids for water, are either produced abnormally in the tissues or are stored in excessive amounts." Thus the glaucomatous eye contains an increased amount of fluid, not from the forcing of more fluid into the eye through the blood-vessels, but because changes occurring in the intra-ocular content cause it to absorb an increased amount of water. Thomas has found that a solution of sodium citrate, used subconjunctivally, is capable of counteracting the effect of acids in increasing the affinity of colloids for water.

Thomas and Heller (1910) have reported great benefit from subconjunctival injections of sodium citrate—5 to 15 drops of a 4.5-per-cent. solution. This treatment, which may be repeated at intervals varying from two to ten days, causes a marked reduction of tension with relief of pain and improvement of vision. Thus the eye is placed in a more favorable condition for iridectomy. Miotics and subconjunctival injections may be used simultaneously.—(J. M. B.)

Sodium dimethylarsenate. See **Sodium cacodylate** and **Venarsen.**

Sodium fluoride. See **Fluorol,** p. 5232, Vol. V of this *Encyclopedia.*

Sodium hyposulphite. SODII THIOSULPHAS, U. S. SODIUM THIOSULPHATE. $Na_2S_2O_3+5H_2O$. This agent is found in large, transparent, colorless, odorless prisms with a cooling, bitter, alkaline taste. It is very soluble in water and is generally used as an antizymotic, like the true sulphites.

Jackson (*Text-book,* p. 256) advises the employment of 5 to 10 per cent. solutions of this salt in the treatment of Parinaud's conjunctivitis. In *argyrosis* (q. v.) Marquez and others report good results from the instillation of a 5 per cent. solution of this hyposulphite preceded by the use of cocain.

Sodium iodate. $NaIO_2$. This salt is generally used as an alterative in diseases of mucous membranes. Darier (*La Clin. Ophtal.*, July, 1908) draws attention to the fact that Schiele has lauded *subconjunctival injections* of iodate of sodium of 1/1000 on account of its analgesic and resolvent qualities. In iritis and glaucoma he has obtained a marked lessening of the pain and a diminution of the hypertension and he supposes that there is a formation in the ocular media of nascent iodine with its powerful action on rheumatic, syphilitic and tuberculous affections. Darier himself has found that in several cases of secondary glaucoma a single subconjunctival injection of a milligramme of iodate of soda has led to a rapid clearing of the cornea, a more or less complete cessation of pain and a marked diminution of intra-ocular tension, and he has also found that this anti-glaucomatous action although very marked for iodate of sodium is not appreciable for potassium iodide. The latter writer reports eleven cases in which he has used the iodate in this way and concludes that we possess in this drug a specific agent against secondary ocular hypertension. He says that it cannot be relied on in essential glaucoma; indeed in such cases the injection of the iodate may provoke an acute attack.

Sodium iodide. NATRIUM IODATUM, P. G. NaI. This salt, when anhydrous, occurs as a white, inodorous, crystalline powder, with a saline, bitterish taste. It is very soluble in water and alcohol; soluble in glycerin.

Sodium iodide is used as a substitute for potassic iodide both internally and locally in the same dosage and is given in the same manner. (See **Potassium iodide.**) It is preferred by some ophthalmologists who believe it to be less toxic and less irritating to the ocular tissues.

Schiele found its subconjunctival action of especial value. He used 0.10 solutions (not boiled but freshly prepared) to which from one to three drops of a 1 per cent. solution of acoin (q. v.) were added to each syringeful to make the injections painless. The conjunctiva was first anesthetized by instillations of cocain, or cocain and atrabilin. Pain after the injections was either very slight or entirely absent. No edema of the conjunctiva or swelling of the eyelids was seen in any case. The injections were made far back from the cornea, to avoid injuring any of the large conjunctival vessels. No adhesion between the conjunctiva and sclera, or necrosis of the tissue was observed. These injections of a syringeful of 1 1,000 sodium iodide solutions were repeated not oftener than every three or four days, and were used in iritis, cyclitis, keratitis, secondary glaucoma, and panoph-

thalmitis with marked relief of the pain, which decreased decidedly within a few hours, disappeared entirely or was slight afterwards.

To bring about absorption of the plaques of scleritis, massage with the following mixture has been found extremely helpful: Sodii iodidi, 0.25; Petrolati, 10.00.

To be used in conjunction with other treatment.

Sodium saccharate. More properly, SODIUM SACCHARIN. SOLUBLE GLUSIDE. SOLUBLE SACCHARIN. This agent is made from aqueous solutions of saccharin with sodium carbonate. It occurs in colorless, intensely sweet crystals, very soluble in water.

In intractable, though superficial ulcer of the cornea, Webster Fox (*Text-book*, p. 157) has found subconjunctival injections of great value. He uses the following formula: Sodii saccharat., gr. xv; Aquæ dest., fl. ℥i.

Sodium saccharin. See **Sodium benzosulphinide** and **Sodium saccharate.**

Sodium salicylate. NATRIUM SALICYLICUM, P. G. $NaC_7H_5O_3$. This well-known salt occurs as a fine, white, crystalline powder with a faint odor and a sweetish saline or alkaline taste. It is freely soluble in water, glycerin, and alcohol. Its solutions are feebly acid.

Comparatively few of the many compounds of sodium are used in ophthalmic surgery although these few are among our most valuable remedies. They are in particular incompatible with acids and vegetable astringents. As a rule they are employed as detergents, irrigating fluids and in collyria.

Although we are best acquainted with this drug as an anti-rheumatic agent given internally it must not be forgotten that it is also of great value in ocular affections of a different origin, that it has been extensively employed in the form of sub-conjunctival injections and even as the chief constituent of collyria. In the form of sub-conjunctival medication (0.025 of the salicylate with 0.005 grm. of cocain) van Moll was among the first to use it.

The best results in the internal exhibition of this remedy are obtainable only by the observance of certain rules, first formulated by Harold Gifford. He advises its use in all non-specific inflammations of the iris, ciliary body, sclera and episcleral tissues, whether of rheumatic origin or not; in acute retrobulbar neuritis and in glaucoma. He has found the average patient will stand during the waking hours, i. e., 7 a. m. to 10 p. m., one grain to each pound of his weight, and gives it as follows: One ounce of the salicylate is dissolved in four ounces of brandy, which gives approximately 15 grains to the teaspoonful. This is administered every 1½ hours in about 1-8 glass of

water followed by the same amount of water or a cracker to ged rid of the taste; it is best to begin with a smaller amount at first and the patient should go to bed after the third or fourth dose, being allowed to go without the drug for a day or two each third or fourth day. He is also warned to keep the head wiped dry, if there is perspiration, as a severe cold may be taken. If the stomach rebels, a change to giving the drug in capsules, followed by the brandy and water, may be resorted to. Temporary blindness and deafness, as toxic sequels, are extremely exceptional and need have no more weight than the blindness which results from moderate doses of quinin. Some cases of delirium have been reported following its use. The writer has tried aspirin with about the same unpleasant symptoms when enough to produce good results was exhibited. In cases classed as optic neuritis there are many conditions not really inflammatory, but due to stasis or thrombosis, in which more faith is placed in large doses of the iodides than of the salicylate; as also in posterior chorioretinitis. Special stress is laid upon the use of this salicylate in sympathetic ophthalmia, post-operative or traumatic inflammations of the iris and ciliary body, interstitial keratitis and herpes corneæ.

In sympathetic ophthalmia Gifford places it ahead of mercurial inunctions but frequently uses the two alternately. Emphasis is laid upon the necessity of keeping up the use of the salicylate one or two days a week for a long time after the last sign of acute inflammation has disappeared.

In interstitial keratitis, plainly the result of hereditary syphilis, the action of the salicylate is much less active and certain than in those that show no marked luetic signs, but even here it often does more good than both iodides and mercury. Those cases of iritis that not infrequently occur after cataract extraction respond most promptly to the general use of the drug.

In herpes corneæ the use of the salicylate in connection with local applications of an iodide gives relief where hot applications and atropin fail.

In explaining the drug's action, the rapid elimination from the body by the kidneys is against its being a germicide or germ-hindering substance, as a 1-1,000 to 1-500 solution is necessary to check the growth of ordinary white and yellow pus cocci. The theory of Oltramare is more plausible, according to which "a local depletion is produced by general capillary dilatation which the salicylate causes." In this connection reference is made to the remarkably favorable influence which an optico-ciliary neurectomy (in which a large part of the blood supply to the eye is cut off) exerts upon traumatic in-

flammations, and the action of cardiac depressants in checking colds. The diaphoresis produced is considered as a secondary factor in the good influences produced by the drug.

Since the date of van Moll's paper, just referred to, it has been discovered (see **Sub-conjunctival injections**) that sodic chloride and other less irritant salts are as clinically useful in kerato-iritis and scleritis, so that the salicylate is now less rarely used in those forms.

As a wash in erythema of the lids Ohlemann advises the following mixture: Mist. oleoso-balsamicæ, 1.50 (gr. xxiii); Sodii salicylatis, 3.0 (gr. xlvi); Aquæ dest., 150.0 (f ℥ iv, f ʒ vi).

W. H. Dudley is in the habit of prescribing fluid extract or tincture of strophanthus in ordinary doses, with sodic salicylate, because of the decided cathartic action thus produced.

Desiring to avoid the depressing effects of the salicylate upon the heart he added five minims of the tincture of strophanthus per dose, the use of which produced free catharsis; quite a good number of trials of a modification of the mixture have invariably produced the same results. The mixture has thus a special indication, where salicylates are indicated, and in cases associated with constipation.

Ball (*Modern Ophthalmology*, p. 274) advises that if in phlyctenular conjunctivitis the usual remedies do not relieve the symptoms sodium salicylate should be administered in relatively large doses (3 grains every four hours for a child of five). The effects must be carefully watched, and if improvement does not follow after a few days the drug should be discontinued.

Toxic amblyopia is (but rarely) seen after excessive doses of the salicylate, the symptoms being much the same as those found after using salicylic acid (q. v.).

Sodium salt of saccharin. See **Sodium benzosulphinide.**

Sodium sozoiodolate. Sozoiodole-sodium. This is one of a numerous class of organic compounds, mostly of German origin, with metallic bases (aluminum, zinc, potassium, silver, mercury, lead) and preferred on account of its great solubility (1:3) in water. It occurs as odorless, colorless, acicular crystals and is applied as a salve with lanoline, or used as a 2 to 8 per cent. collyrium.

It has been recommended by Goldzieher in all small and medium sized ulcers of the cornea and as a stimulant to absorption of the exudates in parenchymatous keratitis in the form of a half to one per cent. ointment with massage and in conjunction with atropia. The same writer has successfully applied this remedy in cases of scleritis as a 1:40 ointment in vaselin.

A. R. Chiappella (*Centralbl. f. Pkt. Augenheilk.*, 1897) reports the

satisfactory employment of several of these compounds in the form of solution or ointment (2 to 5 per cent.) and powder, especially in lachrymal infections, corneal ulcer, as well as for phlyctenular diseases and the accompanying facial eczema.

Sodium sulphate. GLAUBER'S SALT. NATRIUM SULFURICUM. Na_2SO_4. This well known salt crystallizes in large, transparent, colorless, odorless prisms, having a saline, cooling but bitter taste. It is quite soluble in water.

Some years ago the Editor drew attention (Hare's *Therapeutics*) to its use as a cleansing lotion for acute catarrhal conjunctivitis with secretion, but he has not since seen a reference to its employment in the local treatment of eye diseases. He then advocated the following: Sodii sulphatis, 5.00 (ʒ ii gr. xv); Sol. sodii chlor. (1:100) 250.00 (fl. ℥ viii).

It should be used warm, four or five times daily.

Sodium tetraborate. See **Sodium borate.**

Sodium tetraiodophenolphthalein. See **Antinosin,** p. 518, Vol. I of this *Encyclopedia.*

Sodium thiosulphate. See **Sodium hyposulphite.**

Soemmering, Detmar Wilhelm. A distinguished ophthalmologist, son of the still more famous Samuel Thomas von Soemmering. Born at Frankfort-on-the-Main, June 27, 1793, he received his medical degree at Göttingen, in 1816, presenting as dissertation "De Oculorum Hominis Animaliumque Sectione Horizontali." He practised for many years in Frankfort, where, on June 8, 1866, his "doctor-jubilee" was celebrated. He died in the same city Aug. 14, 1871.—(T. H. S.)

Soemmering, Samuel Thomas von. A distinguished German ophthalmologist, son of Dr. Johann Thomas, and father of Dr. Detmar Wilhelm Soemmering, the latter also an ophthalmologist of extraordinary ability. Born at Thorn, in West Prussia, Jan. 25, 1755, he received his medical degree at Göttingen in 1778, presenting as dissertation "De Basi Encephali et Originibus Nervorum Cranio Egredientium Libri V." He is said to have been a brilliant student. The next two years he spent in travel. In 1779 he was appointed instructor in anatomy and surgery at the Carolinum in Cassel, but in 1784 removed to Mayence in order to accept the chair of anatomy and physiology in the University at that place. Here he received in 1787 the title of "Hofrath." In 1796, however, he resigned his position on the faculty, and entered into private practice, still in Mayence. In 1804, he removed (because of the death of his wife) to Munich, and here he became Bavarian Privy Councillor and Fellow of the Academy of Sciences. Here, too, it is claimed by the Germans, that he invented

the electric telegraph. In 1820 he returned to Frankfort, where he remained until his death. His fifty-year "doctor-jubilee" was celebrated April 7, 1828, on which occasion a memorial medal was struck. From the surplus of the funds which had been contributed for this medal, a prize was founded, "the Soemmering prize." This was awarded, quadrennially, for the best performances in physiology, during the past four years, an account of which should be contributed to the Senckenberger (Frankfort) Society for Natural Investigations. Soemmering died of old age Mar. 2, 1830.

His most important ophthalmologic writings are as follows: 1. *Adams, Buesch und Lichtenberg, über einige Wichtige Pflichten gegen die Augen, mit Anmerkungen von S.* (Frankfort, 1794; 5 ed., 1819.) 2. *Abbildungen der Menschlichen Sinnesorgane, mit Deutsch. und Latein. Text.* (4 Lief. Frankf., 1801-10: *"Auge"* 1801-4; *"Gehörorgan"* 1805; *"Geschmak und Stimme"* 1806; *"Geruch"* 1809-10. *"Das Auge"* is undoubtedly his masterpiece.)—(T. H. S.)

Soemmering's mirror. A plane mirror, disc-shaped and smaller than the pupil of the eye, used in micrography in place of the camera lucida.

Soemmering's spot. The macula lutea, or yellow spot of the retina.

Soft cataract. A cataract in which the cortical portion, also sometimes the nucleus, is of soft consistence, as distinguished from the hard, senile cataract.

Soft chancre. See the **Chancre** captions beginning with p. 1997, Vol. III of this *Encyclopedia.* It may be mentioned here in addition that of sixty-six cases of soft chancre of the head Eudlitz (*Archives Gén. de Méd.,* 1897) found three on the eyelids.

Soft paraffin. See **Cosmoline,** p. 3543, Vol. V of this *Encyclopedia.*

Soft soap. Made from *potassium* hydroxide and olive, almond, linseed or similar oil. See **Soap.**

Soie pour suture de la cornée. (F.) Silk for corneal sutures.

Solandrin. This drug is an alkaloid derived from solanin, isolated from *Solandra lævis* by Petrie (*Chem. and Drug.,* 1908, p. 14). It belongs to the atropin group and resembles hyoscin, but differs from it and its aurochloride in not changing the color of red litmus or phenolphthalein and in yielding atropic acid instead of tropic acid when hydrolyzed.

Solanin. A poisonous mydriatic (?) obtainable as a white, opaque powder or crystalline substance from *Solanum nigrum* and other solanaceous plants.

Solanum chenopodioides. A Chilean plant allied to *Solanum nigrum.* The juice of the berries is used in fevers and in eye diseases.

Solanum dulcamara. Woody nightshade. Bittersweet. The younger branches of this plant are used in medicine and possess diuretic, diaphoretic and probably narcotic, mydriatic (cycloplegic) properties and is used chiefly in skin diseases. The bright-yellow berries are poisonous. Although, in common with other solanaceæ this plant possesses mydriatic qualities it has not been employed to any extent in eye diseases.

Solanum maniacum. A synonym of *Atropa belladonna.*

Solanum nigrum. Garden nightshade. Houndberry. A low-growing annual plant, of which there are numerous varieties and closely related species. The herbaceous parts, or leaves contain *solanin.* In India they are used as a soothing application in eye diseases.

Solar blindness. See **Eclipse amblyopia,** p. 4127, Vol. VI of this *Encyclopedia.*

Solar camera. A copying camera for use with direct solar light.

Solar chronometer. A sun dial graduated to indicate solar time.

Solar eye-piece. The eye-piece of a helioscope, provided with a shade in which light is absorbed, but not dispersed.

Solar glaring. See **Eclipse amblyopia.**

Solarization. (a) Exposure to the action of the sun's rays. (b) In photography, reversal of photogenic action due to over-exposure to light.

Solarize. (a) To modify in some way by the action of solar rays. (b) In photography, to affect injuriously by over-exposure.

Solar microscope. An apparatus for projecting upon a screen by means of sunlight an enlarged view of an object. It is essentially an optical lantern taken in conjunction with a plane reflecting mirror which by means of clock-work follows the sun's apparent motion so as always to throw its rays in one direction. By this instrument the rays are thrown horizontally into the solar microscope, are concentrated by lenses upon the small object and, emerging, are focussed sharply on a screen.

Solar observatory. An astronomical observatory, specially equipped for the study of solar phenomena.

Solar print. A photograph, usually enlarged, printed in a solar camera.

Solar-radiation register. A sunshine recorder.

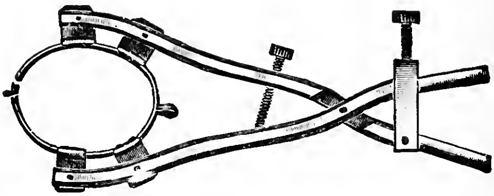
Solar retinitis. See **Retinitis, Solar.**

Solar spectrum. The spectrum (q. v.) due to the refraction of a beam of sunlight.

Solbad. (G.) A saline bath.

Soldering forceps. A tool used by the optician. Four adjustable jaws are provided with asbestos pads so that the heaviest ring may readily

be hard soldered. No wiring of the job to charcoal is required. It will hold articles of all kinds of irregular shapes, also flat surfaced articles. Work may be drawn together by means of the adjusting clamp with screw. They are provided with long handles, not shown in the accompanying figure.



Soldering Forceps.

Soldiers and sailors, Examination of the eyes of. See **Eyes of soldiers, sailors, railway and other employees, Examination of the,** p. 5038, Vol. VII; **Marksmanship,** p. 7599, Vol. X; and **Sharpshooters** in this *Encyclopedia.*

Recruits are admitted to the French and Belgian armies with vision of one-half in one eye and one-tenth, or one-twentieth in the other, with or without correcting lenses. Hence some, losing their glasses, suffer great reduction in vision and efficiency. Weekers (*Oph. Year-Book,* p. 54, 1916) discusses the problem of replacing their correcting lenses. He finds minutely exact corrections unnecessary, and very few with over 3 D. to provide for. With circular eye-holes a lens of given strength can be set for any meridian. In this way 45 different lenses can be made to provide for practically all emergencies. If each recruit had the formula of his correcting lenses noted on his papers, it would save the need of measuring his ametropia at the front.

Solefugous. Shunning sunlight; fleeing from the light of day; nocturnal.

Solferino. The color of rosaniline.

Solid angle. An angle made by three or more plane angles touching one another and meeting in a point.

Solid cataract. Hard cataract.

Solid edema. See **Elephantiasis,** p. 4279, Vol. VI of this *Encyclopedia.*

Walter B. Weidler (*Am. Journ. of Ophthalm.*, Oct., 1918) describes three cases of solid edema treated by vaccines with marked success. He quotes Albutt and Roleston's *System of Medicine,* IX, 183, for an addition to the already long list of synonyms by which this disease has long been known—among them *recurrent erysipelas* (J. Hutchin-

son), *erysipelas persistans faciei* (Kaposi), *erythema persistans faciei* (Kreibush), *lymphangitis faciei* (S. MacKenzie), and *persistent lymphatic edema.*

Solisequious. Following the course of the sun.

Solitary tubercle of the choroid. This deposit may simulate the early stages of leucosarcoma (q. v.) but it is not accompanied by the development of bloodvessels, and is found almost exclusively in young tuberculous subjects.

Solitary tubercle of the iris. See p. 6641, Vol. IX of this *Encyclopedia.*

Sol-lunar. Proceeding from, or due to, the influence of both the sun and the moon.

Soloid. This is a trade name (Burroughs, Welcome & Co.) given to soluble tablets for the preparation of fresh solutions of drugs. They are a convenient means of carrying about especially agents that in solution are likely to deteriorate in a short time—certain collyria, for example.

Solomon, Vose. A well-known English surgeon, of especial renown in diseases of the eye. Born at Birmingham, England, the son of a physician, he studied at St. Bartholomew's Hospital, London, and became, in 1833, M. R. C. S., and F. R. C. S. in 1854. For a number of years he was surgeon to the Birmingham Eye Infirmary, and professor of ophthalmology at Queen's College. He wrote no book, but a number of articles on glaucoma, intra-ocular myotomy in myopia, etc. He died on his estate, Villafranca, near Birmingham, Sept. 10, 1899, aged 82.—(T. H. S.)

Solubes. These are tablets, better known in Great Britain, of remedial agents combined chiefly with sodium chloride and colored blue. They are of several sizes, and are intended for solution in various quantities of sterile water. The smaller are used in ophthalmic practice.

Soluble gluside. See **Sodium saccharate.**

Soluble saccharin. See **Sodium saccharate.**

Solurol. Thyminic acid. Nucleotinphophoric acid. This remedy is a yellow, amorphous powder easily soluble in water and prescribed in gout, rheumatism, Graves' disease and in the so-called uric acid diathesis generally. The usual dose is from four to eight grains (0.25 to 0.50). Wolfberg has given it internally in full doses for its effect upon cataract (q. v.) due to the general causes mentioned.

Solution, Carrel-Dakin. The mode of preparing this remedy, so widely used in war wounds, has been described by A Carrel (*Journ. Am. Med. Assocn.*, p. 1777, Dec. 9, 1916), as follows: Dakin's solution is a solution of sodium hypochlorite for surgical use, the charac-

teristics of which, established after numerous tests and a long practical experience, are as follows:

(a) Complete absence of caustic alkali.—The absolute necessity for employing in the treatment of wounds a solution free from alkali hydroxid excludes the commercial Javel water, Labarraque's solution, and all the solutions prepared by any other procedure than the following:

(b) Concentration.—The concentration of sodium hypochlorite must be exactly between 0.45 and 0.50 per cent. Below 0.45 per cent. of hypochlorite the solution is not sufficiently active; above 0.50 per cent. it becomes irritating.

Chemicals required for the preparation.—Three chemical substances are indispensable to Dakin's solution: chlorinated lime, anhydrous sodium carbonate and sodium bicarbonate. Among these three products the latter two are of a practically adequate constancy, but this is not the case with the first. Its content in active chlorin (decloring chlorin) varies within wide limits, and it is absolutely indispensable to titrate it before using it.

Trituration of the chlorinated lime.—There must be on hand for this special purpose:

A 25 c.c. buret graduated in 0.1 c.c.

A pipet gaged for 10 c.c.

A decinormal solution of sodium thiosulphate can be obtained in the market; it can also be prepared by dissolving 25 gm. of pure crystalline sodium thiosulphate in 1 liter of distilled water, and verifying by the decoloration of an equal volume of the decinormal solution of iodin by this solution. The iodin is prepared by dissolving 1.27 gm. iodin and 5 gm. potassium iodid in 100 c.c. of water.

The material for the dosage thus provided, a sample of the chlorinated lime on hand is taken up either with a special sound or in small quantities from the mass which then are carefully mixed.

Weigh out 20 gm. of this average sample, mix it as completely as possible with 1 liter of ordinary water, and leave it in contact for a few hours, agitating it from time to time. Filter.

Measure exactly with the gaged pipet 10 c.c. of the clear fluid; add to it 20 c.c. of a 1 : 10 solution of potassium iodid and 2 c.c. of acetic or hydrochloric acid. Drop, a drop at a time, into this mixture a decinormal solution of sodium thiosulphate until decoloration is complete.

The number of cubic centimeters of the hypochlorite solution required for complete decoloration, multiplied by 1.775, gives the weight of the active chlorin contained in 100 gm. of the chlorinated lime.

This figure being known, it is applied to the accompanying table, which will give the quantities of chlorinated lime, of sodium carbonate

and of sodium bicarbonate which are to be employed to prepare 10 liters of Dakin's solution.

Quantities of Ingredients for Ten Liters of Dakin's Solution.

Liter of Chlorinated Lime	Chlorinated Lime, Gm.	Anhydrous Sodium Carbonate, Gm.	Sodium Bicarbonate, Gm.
20	230	115	96
21	220	110	92
22	210	105	88
23	200	100	84
24	192	96	80
25	184	92	76
26	177	89	72
27	170	85	70
28	164	82	68
29	159	80	66
30	154	77	64
31	148	74	62
32	144	72	60
33	140	70	59
34	135	68	57
35	132	66	55
36	128	64	53
37	124	62	52

Example: If it required 16.6 c.c. of the decinormal solution of the sodium thiosulphate for complete decoloration, the titer of the chlorinated lime in active chlorin is:

$$16.6 \times 1.775 = 29.7 \text{ per cent.}$$

The quantities to be employed to prepare 10 liters of the solution will be in this case:

Chlorinated lime .... 154 gm.
Dry sodium carbonate.................... 77 gm.
Sodium bicarbonate .... 62 gm.

If crystalline sodium carbonate is being used, then instead of the 80 gm. of dry carbonate it must be replaced by:

Crystalline sodium carbonate.............. 220 gm.

Preparation of Dakin's solution.—To prepare 10 liters of the solution:

1. Weigh exactly the quantities of chlorinated lime, sodium car-

bonate and sodium bicarbonate which have been determined in the course of the preceding trial.

2. Place in a 12-liter jar the chlorinated lime and 5 liters of ordinary water, agitate vigorously for a few minutes, and leave in contact for from six to twelve hours, over night, for instance.

3. At the same time dissolve, cold, in the five liters of water the sodium carbonate and the bicarbonate.

4. Pour all at once the solution of the sodium salts into the jar containing the maceration of chlorinated lime, agitate vigorously for a few moments, and leave it quiet to permit the calcium carbonate to settle as it forms. At the end of half an hour, siphon the liquid and filter it through double paper to obtain an entirely limpid product, which must be protected from light.

Light, in fact, alters quite rapidly solutions of hypochlorite, and it is indispensable to protect from its action the solutions which are to be preserved. The best way to realize these conditions is to keep the finished fluid in large wicker-covered demijohns of black glass.

Titration of Dakin's solution.—It is a wise precaution to verify, from time to time, the titer of the solution. This titration utilizes the same material and the same chemical substances as are used to determine the active chlorin in the chlorinated lime:

Measure out 10 c.c. of the solution, add 20 c.c. of 1:10 solution of potassium iodid, and 2 c.c. of acetic or hydrochloric acid. Drop, a drop at a time, into this mixture a decinormal solution of sodium thiosulphate until decoloration is complete.

The number of cubic centimeters employed multiplied by 0.03725 will give the weight of the sodium hypochlorite contained in 100 c.c. of the solution.

A solution is correct when, under the conditions given above, from 12 to 13 c.c. of decinormal thiosulphate are required to complete the decoloration:

$$13 \times 0.03725 = 0.485 \text{ per cent. of NaOCl}$$

The test for the alkalinity of Dakin's solution.—It is easy to differentiate the solution obtained by this procedure from the commercial hypochlorites and from Labarraque's solution:.

Pour into a glass about 20 c.c. of the fluid, and drop on the surface a few centigrams of phenolphthalein in powdered form. Dakin's solution, correctly prepared, gives absolutely no change in tint, while in the same conditions Javel water and Labarraque's fluid give an intense red coloration which indicates in the latter two solutions the presence of free caustic sodium.

See, also, **Military surgery of the eye**; and **Solution of chlorinated soda.**